SHOUT
SHARE
IT

(16)

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

Volume XXII, 1906.

69 plates Bound
where they are

NEW YORK.
PUBLISHED BY ORDER OF THE TRUSTEES.
FOR SALE AT THE MUSEUM.

1906.

85919
25/2/08

QH
1
A4
v. 22

EDITOR.

J. A. ALLEN.

AMERICAN MUSEUM OF NATURAL HISTORY.

Seventy-seventh Street and Central Park West, New York City.

OFFICERS.

President.
Morris K. Jesup.

First Vice-President.
J. Pierpont Morgan.

Second Vice-President.
Henry F. Osborn.

Treasurer.
Charles Lanier.

Secretary.
J. Hampden Robb.

Director.
Hermon C. Bumpus.

BOARD OF TRUSTEES.

Class of 1906.
Charles Lanier.
Anson W. Hard.
William Rockefeller.
Gustav E. Kissel.
Seth Low.

Class of 1907.
D. O. Mills.
Archibald Rogers.
Albert S. Bickmore.
Cornelius C. Cuyler.
Adrian Iselin, Jr.

Class of 1908.
H. O. Havemeyer.
A. D. Juilliard.
Frederick E. Hyde.
George S. Bowdoin.
Cleveland H. Dodge.

Class of 1909.
Morris K. Jesup.
Joseph H. Choate.
J. Pierpont Morgan.
George G. Haven.
Henry F. Osborn.

Class of 1910.
J. Hampden Robb.
James H. Hyde.
Percy R. Pyne.
Arthur Curtiss James.

SCIENTIFIC STAFF.

DIRECTOR.

Hermon C. Bumpus, Ph.D., Sc.D.

DEPARTMENT OF PUBLIC INSTRUCTION.

Prof. Albert S. Bickmore, B.S., Ph.D., LL.D., Curator Emeritus.
George H. Sherwood, A.B., A.M. Curator.

DEPARTMENT OF GEOLOGY AND INVERTEBRATE PALÆONTOLOGY.

Prof. R. P. Whitfield, A.M., Curator.
Edmund Otis Hovey, A.B., Ph.D., Associate Curator.

DEPARTMENT OF MAMMALOGY AND ORNITHOLOGY.

Prof. J. A. Allen, Ph.D., Curator.
Frank M. Chapman, Associate Curator.

DEPARTMENT OF VERTEBRATE PALÆONTOLOGY.

Prof. Henry Fairfield Osborn, A.B., Sc.D., LL.D., D.Sc., Curator.
W. D. Matthew, Ph.B., A.B., A.M., Ph.D., Associate Curator
O. P. Hay, A.B., Ph.D., Associate Curator of Chelonia.
Prof. Bashford Dean, A.B., A.M., Ph.D., Honorary Curator of Fishes.

JESUP NORTH PACIFIC EXPEDITION.

Prof. Franz Boaz, Ph.D., in Charge.

DEPARTMENT OF ETHNOLOGY.

Clark Wissler, A.B., A.M., Ph.D., Acting Curator.
Harlan I. Smith, Assistant Curator.
George H. Pepper, Assistant.
Charles W. Mead, Assistant.

DEPARTMENT OF ARCHÆOLOGY.

Prof. Marshall H. Saville, Associate Curator.

DEPARTMENT OF ENTOMOLOGY.

WILLIAM BEUTENMÜLLER, Curator.

DEPARTMENTS OF MINERALOGY AND CONCHOLOGY.

L. P. GRATACAP, Ph.B., A.B., A.M., Curator.
GEORGE F. KUNZ, A.M., Ph.D., Honorary Curator of Gems.

DEPARTMENT OF BOOKS AND PUBLICATIONS.

Prof. RALPH W. TOWER, A.B., A.M., Ph.D., Curator

DEPARTMENT OF INVERTEBRATE ZOÖLOGY.

Prof. WILLIAM MORTON WHEELER, Ph.D., Curator.
ROY W. MINER, A.B., Assistant Curator.
B. E. DAHLGREN, D.M.D., Assistant Curator.

DEPARTMENT OF PHYSIOLOGY.

Prof. RALPH W. TOWER, A.B., A.M., Ph.D., Curator.

DEPARTMENT OF MAPS AND CHARTS.

A. WOODWARD, Ph.D., Curator.

CONTENTS OF VOLUME XXII.

PAGE
Title-page i
Officers and Trustees iii
Scientific Staff iv
Contents vi
Dates of Publication of Authors' Separates viii
List of Illustrations viii
List of New Names of Higher Groups, Genera, Species, and Subspecies. xii

ART. I.—The Habits of the Tent-Building Ant (*Cremastogaster lineolata* Say). By WILLIAM MORTON WHEELER. (Plates I–VI) 1
II.—On the Skull of *Edaphosaurus pogonias* Cope. By E. C. CASE. (Plate VII) 19
III.—Descriptions of Two New Genera (*Echmatemys* and *Xenochelys*) and Two New Species (*Xenochelys formosa* and *Terrapene putnami*) of Fossil Turtles. By OLIVER P. HAY 27
IV.—On the Founding of Colonies by Queen Ants, with Special Reference to the Parasitic and Slave-Making Species. By WILLIAM MORTON WHEELER. (Plates VIII–XIV 33
V.—The Orthoptera of the Bahamas. By JAMES A. G. REHN 107
VI.—The Myzostomes of the 'Albatross' Expedition to Japan. By J. F. MCCLENDON. (Plates XV–XVII) 119
VII.—Notes on Some Jurassic Fossils from Franz Josef Land, brought by a Member of the Ziegler Exploring Expedition. By R. P. WHITFIELD. (Plates XVIII, XIX) 131
VIII.—New or Little Known Mammals from the Miocene of South Dakota. By W. D. MATTHEW and J. W. GIDLEY 135
IX.—On Two Interesting Genera of Eocene Turtles, *Chisternon* Leidy and *Anosteira* Leidy. By OLIVER P. HAY 155
X.—List of Birds collected in Northwestern Durango, Mexico, by J. H. Batty, during 1903. By WALDRON DE WITT MILLER 161
XI.—Arachnida from the Bahamas. By NATHAN BANKS..... 185
XII.—Mammals from the States of Sinaloa and Jalisco, Mexico, collected by J. H. Batty during 1904 and 1905. By J. A. ALLEN. (Plates XX–XXXIII) 191
XIII.—Milk Dentition of the Hyracoid Saghatherium from the Upper Eocene of Egypt. By HENRY FAIRFIELD OSBORN 263

PAGE

Art. XIV.—A New Wingless Fly (*Puliciphora borinquenensis*) from Porto Rico. By William Morton Wheeler. (Plate XXXIV) 267

XV.—Volcanic Ash in the Bridger Beds of Wyoming. By W. J. Sinclair. (Plates XXXV–XXXVIII) 273

XVI.—Tyrannosaurus, Upper Cretaceous Carnivorous Dinosaur (Second Communication). By Henry Fairfield Osborn. (Plate XXXIX) 281

XVII.—New Notes on the Osteology of Triceratops. By Barnum Brown. (Plate XL) 297

XVIII.—The Ants of Japan. By William Morton Wheeler. (Plate XLI) 301

XIX.—The Ants of the Grand Cañon. By William Morton Wheeler 329

XX.—The Ants of the Bermudas. By William Morton Wheeler 347

XXI.—Hypothetical Outlines of the Continents in Tertiary Times. By W. D. Matthew 353

XXII.—A New Genus of Horse from the Mascall Beds, with Notes on a Small Collection of Equine Teeth in the University of California. By J. W. Gidley 385

XXIII.—Remarks and Descriptions of Jurassic Fossils of the Black Hills. By R. P. Whitfield and E. O. Hovey. (Plates XLII–LXII) 389

XXIV.—An Ethological Study of Certain Maladjustments in the Relations of Ants to Plants. By William Morton Wheeler. (Plates LXIII–LXVIII) 403

XXV.—The Bees of Florissant, Colorado. By T. D. A. Cockerell 419

XXVI.—A Fossil Cicada from Florissant, Colorado. By T. D. A. Cockerell 457

XXVII.—The Fossil Mollusca of Florissant, Colorado. By T. D. A. Cockerell 459

XXVIII.—Mammals from the Island of Hainan, China. By. J. A. Allen. (Plate LIX) 463

XXIX.—Fossil Parasitic and Phytophagous Hymenoptera from Florissant, Colorado. By Charles T. Brues 491

XXX.—Fossil Saw-Flies from Florissant, Colorado. By T. D. A. Cockerell 499

DATES OF PUBLICATION OF AUTHORS' SEPARATES.

The edition of authors' separates is 200, of which about 70 are mailed on the date of issue, and the others placed on sale in the Library.

Art. I, Jan. 25, 1906.
" II, March 14, 1906.
" III, Feb. 3, 1906.
" IV, May 15, 1906.
" V, " 23, 1906.
" VI, " 26, 1906.
" VII, " 26, 1906.
" VIII, " 26, 1906.
" IX, June 2, 1906.
" X, " 2, 1906.
" XI, July 18, 1906.
" XII, " 25, 1906.
" XIII, " 25, 1906.
" XIV, " 31, 1906.
" XV, " 31, 1906.

Art. XVI, July 30, 1906.
" XVII, Sept. 17, 1906.
" XVIII, " 17, 1906.
" XIX, " 17, 1906.
" XX, " 29, 1906.
" XXI, Oct. 25, 1906.
" XXII, Dec. 19, 1906.
" XXIII, " 17, 1906.
" XXIV, " 17, 1906.
" XXV, " 17, 1906.
" XXVI, " 17, 1906.
" XXVII, " 17, 1906.
" XXVIII, " 17, 1906.
" XXIX, " 17, 1906.
" XXX, " 17, 1906.

LIST OF ILLUSTRATIONS.

Plates.

I and II.—Carton coccid-tents of *Cremastogaster lineolata pilosa* Pergande.
III.—Carton coccid- and aphis-tents of *Cremastogaster lineolata* Say.
IV.—Earthen aphis-tents and carton constructions of *Cremastogaster lineolata* Say.
V.—Carton nest of *Cremastogaster lineolata* Say, var.
VI.—Membracid-tents of *Formica rufa integra* Nyl.
VII.—*Edaphosaurus pogonias* Cope.
VIII.—Incipient ant nests.
IX.—Nests of *Formica integra*.
X.—Nests of *Formica integra* and *F. consocians*.
XI.—Nests of *Formica incerta*.
XII.—Small nests of *Formica exsectoides*.
XIII and XIV.—Large nests of *Formica exsectoides*.
XV.—*Myzostoma chelonium* sp. nov., *M. chelonoidium* sp. nov., *M. antennatum* v. Graff, *M. deani* sp. nov., *M. clarki* sp. nov.
XVI.—*Myzostoma metacrini* sp. nov., *M. smithi* sp. nov., *M. japonicum* sp. nov., *M. cysticolum* v. Graff, *M. wheeleri* sp. nov.
XVII.—*Myzostoma*, various species.
XVIII and XIX.—Jurassic fossils from Franz Josef Land.
XX.—Skulls of *Tayassu angulatum sonoriense*.
XXI–XXVI.—Skulls of *Odocoileus sinaloæ*.
XXVII–XXX.—Skulls of *Nasua narica molaris*.
XXXI–XXXIII.—Antlers of *Odocoileus sinaloæ*.
XXXIV.—*Puliciphora borinquenensis* sp. nov.

XXXV.—Henry's Fork Hill.
XXXVI.—Grizzly Buttes East.
XXXVII.—Bridger Tuffs.
XXXVIII.—Sage Creek Spring.
XXXIX.—Restoration of *Tyrannosaurus rex.*
XL.—Skeleton of *Triceratops prorsus*, front view.
XLI.—Japanese Ants.
XLII–LXII.—Jurassic Fossils of the Black Hills of Dakota.
LXIII–LXVIII.—Photographs of mounds of *Formica exsectoides*, near Scotch Plains, New Jersey.
LXIX.—Skull of *Manis pusilla* sp. nov.; dentition of *Sciurus vulgaris* and *Tamiops macclellandi hainanus*, gen. et subsp. nov.

Text Figures.

PAGE
Cremastogaster lineolata Say, worker 2
" " worker with gaster turned up and directed anteriorly 3
Lasius niger L. var. *americanus* Emery, nest under stone 12
Edaphosaurus, diagram of upper and lower surface of skull 20
" diagram of lateral view of skull 21
" posterior view of skull 22
Placodus, posterior view of skull 22
Edaphosaurus, lower jaw 24
Placodus, palatal view of skull 26
Echmatemys septaria, inguinal buttresses from behind 28
Xenochelys formosa, diagram showing outlines of bones and horny scales of carapace 29
Xenochelys formosa, diagram showing outlines of bones and horny scales of plastron 29
Terrapene putnami, wash-drawing of lower surface of left hypoplastron 30
" " section from midline to hinge 31
" " outline of mesial face of hypoplastron 31
" " view of lateral hinge 31
Artificial ant nest, on principles of Fielde and Janet nests 48
Eurycotis bahamensis sp. nov., male 111
Malacomorpha androsensis gen. et sp. nov., male, side view of last four abdominal segments 114
Hypohippus affinis Leidy, lower teeth 135
" sp. indesc., lower molar 136
Protohippus perditus Leidy, immature skull, three views 137
" " " two views of first true molar 138
" " " upper jaw 138
" *placidus* " lower jaw, external and superior views . . . 141
" *supremus* " skull of young individual 143
" " " upper jaw with milk premolars 144
Neohipparion gratum " side view of anterior part of skull 145
" " " upper jaw, inferior view 146
" " " lower jaw, external view 147

PAGE
Neohipparion gratum Leidy, lower jaw, superior view 148
“ *dolichops* sp. nov., upper jaw 149
“ “ “ molar 149
“ “ lower jaw, external view 150
“ “ “ “ superior view 151
“ *niobrarense* sp. nov., anterior part of skull 151
“ “ lower jaw 152
“ “ upper and lower dentition 153
Chisternon hebraicum Leidy, portion of carapace 155
Anosteira ornata Leidy, view of carapace 157
“ “ “ “ “ plastron 158
Acanthopelma maculata sp. nov., abdomen and eyes 186
Wulfila ventralis sp. nov., vulva 187
Erginus castaneus sp. nov., femur IV, and palpus 189
Tatu novemcinctum mexicanum, side view of three skulls 197
Saghatherium antiquum, upper jaw and teeth 264
Tyrannosaurus, skull, side view 285
Allosaurus, skull, side view 286
Tyrannosaurus, cervical vertebræ 287
“ mid-cervical vertebræ 288
“ sacrum 289
“ and *Allosaurus*, scapula 291
“ pelvis 292
“ humerus 293
“ femur 293
“ “ section 294
“ right pes 294
“ abdominal ribs 295
Triceratops, sternal plates 298
“ “ “ with restoration of cartilaginous ribs 299
Prenolepis flavipes (F. Smith) Mayr, male, outer, median, and inner genital valves 321
Camponotus herculeanus japonicus Mayr and *C. h. pennsylvanicus* De Geer, heads of worker major 324
Prenolepis kincaidi sp. nov., male, outer, median, and inner genital valves 351
Hypothetical continental outlines, Post-Cretaceous 356
“ “ “ Middle Eocene 360
“ “ “ Middle Oligocene 364
“ “ “ Miocene 366
“ “ “ Pliocene 367
“ “ “ Early Pleistocene 369
Modern continental outlines showing the line of 1000 feet depth 372
Archæohippus ultimus (Cope), side and palatal views 386
Broken twig of sunflower, showing ants (*Myrmica brevinodis*) caught and killed by exuding sap 417
Dianthidium cressoni, nest, built of resin and pebbles on a stone 444
Titusella pronitens gen. et sp. nov., fore wing and head 449

PAGE
Lithocicada perita gen. et sp. nov., wing 457
Omphalina (?) *laminarum* sp. nov., impression and cast 460
Planorbis florissantensis Ckll 460
Lymnæa sieverti sp. nov 461
" *scudderi* sp. nov 461
Sphærium florissante sp. nov 461
Lithoryssus parvus gen. et sp. nov., wings 492
Acœnites defunctus sp. nov., fore wings 493
Rhyssa petiolata sp. nov., abdomen and ovipositor 494
Pimpla appendigera sp. nov., fore wing 495
Microgaster primordalis sp. nov., part of fore wing 496
Pantoclis deperdita sp. nov 497
Problematic Bethylid, fore wing 498
Dineura saxorum sp. nov 499
Eriocampa wheeleri sp. nov 500
Hemichroa eophila sp. nov 501

LIST OF HIGHER GROUPS, GENERA, SPECIES, AND SUBSPECIES DESCRIBED OR RENAMED IN THIS VOLUME.

Higher Gpoups

	PAGE
Tyrannosauridæ Osborn	283

Genera

Echmatemys Hay	27
Xenochelys Hay	29
Malacomorpha Rehn	113
Archæohippus Gidley	385
Oreopasites Cockerell	442
Titusella Cockerell	445
Lithocicada Cockerell	457
Tamiops Allen	475
Lythoryssus Brues	491

Species and Subspecies

Xenochelys formosa Hay	29
Terrapene putnami Hay	30
Eurycotis bahamensis Rehn	110
Aphlebia inusitata Rehn	113
Malacomorpha androsensis Rehn	114
Myzostoma cysticolum var. *orientale* McClendon	120
" *clarki* McClendon	121
" *metacrini* McClendon	122
" *wheeleri* McClendon	124
" *deani* McClendon	124
" *smithi* McClendon	125
" *chelonium* McClendon	126
" *chelonoidium* McClendon	126
" *japonicum* McClendon	127
Protohippus simus Matthew and Gidley	139
Neohipparion dolichops Matthew and Gidley	148
(?)*Neohipparion niobrarense* Matthew and Gidley	151
Acanthopelma maculata Banks	185
Wulfila ventralis Banks	186
Erginus castaneus Banks	189
Heteromys pictus escuinapæ Allen	211
Molossus sinaloæ Allen	236
Sciurus poliopus tepicanus Allen	243
Sigmodon vulcani Allen	247
Heteromys jaliscensis Allen	251
Puliciphora borinquenensis Wheeler	269
Sysphincta watasei Wheeler	303
Pachycondyla (*Pseudoponera*) *sauteri* Wheeler	304
Ponera japonica Wheeler	306

PAGE
Myrmecina graminicola nipponica Wheeler 307
Monomorium nipponense Wheeler 310
" *triviale* Wheeler 311
Vollenhovia emeryi Wheeler 312
Stenamma owstoni Wheeler 314
Iridomyrmex itoi abbotti Wheeler 318
Technomyrmex gibbosus Wheeler 319
Solenopsis geminata var. *aurea* Wheeler 336
Pheidole desertorum Wheeler 337
" " var. *comanche* Wheeler 339
" " var. *maricopa* Wheeler 339
Formica moki Wheeler 343
Prenolepis kincaidi Wheeler 350
Ophiocten (?) *bellefourchensis* Whitfield and Hovey 391
Cidaris bellefourchensis Whitfield and Hovey 391
Pinna jurassica Whitfield and Hovey 392
Modiola jurassica Whitfield and Hovey 393
Modiolarca jurassica Whitfield and Hovey 393
Septifera sturgisensis Whitfield and Hovey 393
Astarte dacotensis Whitfield and Hovey 394
Trigonia sturgisensis Whitfield and Hovey 394
" *poststriata* Whitfield and Hovey 396
Tancredia transversa Whitfield and Hovey 396
Quenstedtia planulata Whitfield and Hovey 397
Pleuromya (?) *concentrica* Whitfield and Hovey 397
Pholadomya obscura Whitfield and Hovey 398
Neritoma (?) (*Oncochilus*) *occidentalis* Whitfield and Hovey 399
Belemnites obtusus Whitfield and Hovey 399
Ammonites (*Œgoceras*) *subtumidum* Whitfield and Hovey 400
Prosopis tuertonis Cockerell 423
Colletes sieverti Cockerell 424
" *florissantia* Cockerell 425
" *polemonii* Cockerell 425
Sphecodes sulcatulus Cockerell 426
Halictus (*Evylæus*) *synthyridis* Cockerell 427
" (*Chloralictus*) *scrophulariæ* Cockerell 428
Andrena cyanophila Cockerell 431
" *vicina argentiniæ* Cockerell 432
" *micranthophila* Cockerell 432
" *ribesina* Cockerell 433
" *topazana* Cockerell 434
" *runcinatæ* Cockerell 434
" *lewisii* Cockerell 435
" *fragiliformis* Cockerell 435
" *synthyridis* Cockerell 436
" *sieverti* Cockerell 436
" *lappulæ* Cockerell 437
Nomada rohweri Cockerell 438

PAGE
Nomada cymbalariæ Cockerell.......... 439
Perdita tortifoliæ Cockerell.......... 440
" *florissantella* Cockerell.......... 440
" *wilmattæ* Cockerell.......... 441
Oreopasites scituli Cockerell.......... 442
Melissodes hymenoxidis Cockerell.......... 443
Titusella pronitens Cockerell.......... 446
Osmia cyaneonitens Cockerell.......... 448
" *wheeleri* Cockerell.......... 449
" *hypochrysea* Cockerell.......... 449
" *florissanticola* Cockerell.......... 450
" *albolateralis* Cockerell.......... 450
" *pentstemonis* Cockerell.......... 451
" *subtrevoris* Cockerell.......... 451
" *giliarum* Cockerell.......... 451
Megachile giliæ Cockerell.......... 452
" *wootoni rohweri* Cockerell.......... 453
Andrena colletina Cockerell.......... 454
Lithocicada perita Cockerell.......... 457
Omphalina (?) *laminarum* Cockerell.......... 459
Planorbis florissantensis Cockerell.......... 460
Lymnæa sieverti Cockerell.......... 461
" *scudderi* Cockerell.......... 461
Sphærium florissantense Cockerell.......... 462
Manis pusilla Allen.......... 465
Atherurus hainanus Allen.......... 470
Ratufa gigantea hainana Allen.......... 472
Funambulus riudonensis Allen.......... 472
Sciurus erythræus insularis Allen.......... 473
Tamiops malccellandi hainanus Allen.......... 476
" " *riudoni* Allen.......... 477
Tupaia modesta Allen.......... 481
Rhinolophus hainanus Allen.......... 482
Hipposideros poutensis Allen.......... 483
Scotophilus kuhlii insularis Allen.......... 485
" *castaneus consobrinus* Allen.......... 485
Pipistrellus portensis Allen.......... 487
Lythoryssus parvus Brues.......... 492
Mesostenus modestus Brues.......... 492
Acœnites defunctus Brues.......... 493
Rhyssa petiolata Brues.......... 494
Pimpla appendigera Brues.......... 494
Orthocentrus primus Brues.......... 495
Rhogas tertiarius Brues.......... 496
Microgaster primordialis Brues.......... 496
Pantoclis deperdita Brues.......... 497
Dineura saxorum Cockerell.......... 499
Eriocampa wheeleri Cockerell.......... 500
Hemichroa eophila Cockerell.......... 501

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

VOLUME XXII, 1906.

59.57,96c: 15.

Article I. — THE HABITS OF THE TENT-BUILDING ANT (CREMASTOGASTER LINEOLATA SAY).

By William Morton Wheeler.

Plates I–VI.

The large cosmopolitan, but mainly tropical genus *Cremastogaster* is represented in the United States by some seven different species. These are confined to the Southern and Southwestern States, with the exception of the common *C. lineolata* which ranges over the whole country from the Atlantic and Pacific seaboards to an altitude of about 7000 feet in the Rocky Mountains. Like most of our widely distributed ants, it shows a remarkable tendency to vary. Emery[1] recognizes some ten different varieties and subspecies. He finds, moreover, that this number could be increased by recognizing some of the varieties which connect the subspecies. From the extraordinary variety of these ants that have been accumulating in my own collection, I should say that the number of subspecies and varieties hitherto recorded might readily be doubled. I must postpone, however, a detailed taxonomic study of these ants till some future time.

In such a protean form as *C. lineolata* we should expect to find marked variability in habits. While this is undoubtedly the case, this variability does not seem to be definitely correlated with particular color or form variations, but each single subspecies or variety exhibits a considerable range of adaptations, some of which may manifest themselves only in certain localities or at certain seasons. Thus, in its nesting habits, the beautiful yellow and black var. *clara* of Texas shows much the same range of adaptations as our common northern *lineolata* (typical) and its variety *cerasi*, for all of these forms may be found nesting either in the soil under stones, in dead wood, or under bark, boards, etc. The workers of all of our forms have the same habit of climbing trees and plants in straggling files and of attending aphides and coccids. The excrement of these animals, popularly known as "honey dew," certainly constitutes a large portion of their food. All of our forms have a rank, indescribable odor. When in large colonies, they are often very courageous and sting and bite with great fury. Small colonies, however, or small groups of foraging workers are very timid and when disturbed take refuge in crevices in the bark or depressions in the soil. Like the other members of the genus, *lineolata* workers are able while walking or running to throw up and turn forward the tip of the gaster, so that its flattened dorsal surface becomes ventral and its convex ventral surface becomes dorsal in position. (Figs. 1 and 2.) This peculiar position, however, is not so readily or frequently assumed as in some of the tropical American species, like *C. minuta* and *C. ashmeadi.*

---

[1] Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Abth. f. Syst. VIII, 1894 pp. 280–286.

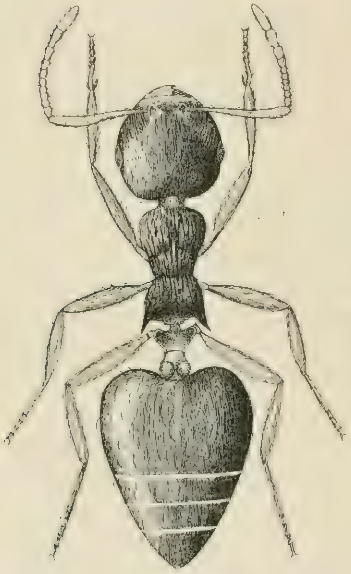


Fig. 1. Cremastogaster lineolata Say. Worker.

Among the habits of *C. lineolata* there is one that is as striking in its manifestation as it is obscure in its phylogenetic origin, — the habit of constructing, often at some distance from the ground or the nest, small enclosures, variously designated as 'tents,' 'pavilions' or 'cowsheds' over colonies of aphides or coccids. These structures, which consist of agglutinated earth or vegetable detritus, have been described by several observers, though they have neither been adequately figured nor satisfactorily explained. Such tents are erected by other ants, but those of *C. lineolata* seem to show greater perfection of workmanship and a higher degree of adaptation to special conditions.

One of the earliest accounts of these structures among our American ants was published by Baron Osten Sacken in 1862.[1] His article, which was translated and republished in 'Psyche' twenty years later,[1] is here quoted in full:

---

[1] Entomologische Notizen. VII. Stallfütternde Ameisen. Stett Entomol. Zeitg., 23 Jahrg. 1862, pp. 127, 128.

"On a horizontal twig of a juniper (*J. virginiana*), about five feet from the ground, I observed a colony of a species of *Lachnus.* A small reddish ant with a brown abdomen was diligently working at a tube-shaped structure of soft, grayish brown, felt-like material, enclosing the twig in a kind of sheath. The material probably consisted of short fibers of liber closely packed together; it had a pitchy smell, burnt well, the smoke having the same smell, but stronger. The structure was about an inch long and one third of an inch in diameter.

"The second case observed by me was near the Berkeley Springs, in Virginia. A black ant had built a globular structure of a sandy material, of about an inch and a half in diameter, around the stem of an *Asclepias*, which was closely packed with aphides. Although the sand was sufficiently mixed with clay to have the necessary consistence, and although several leafstalks served as supports, the structure was so brittle that I did not succeed in bringing it home. "

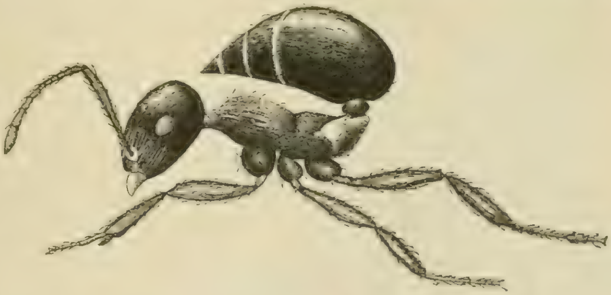


Fig. 2. Cremastogaster lineolata Say. Worker with the gaster turned up and directed anteriorly.

It is clear from Osten Sacken's description that the two aphis-tents which he observed were made of very different materials, one being of felted vegetable detritus, the other of sand and clay. As all the tents described by subsequent writers consist of one or the other of these two substances they may be distinguished as the carton and earthen types, respectively. In the original German paper Osten Sacken ascribes the felted or carton nest to a *Formica*, but it is very probable that both of the tents were constructed by forms of *C. lineolata*, for the term *Formica* need not be construed in the restricted modern sense; the fact that it was omitted in the translation may be taken to indicate that Osten Sacken may have employed it in a general sense as synonymous with the word 'ant.'

---

[1] Ants and Aphides. Psyche, Vol. III, No. 97, May 1882, p. 342.

A year after the publication of Osten Sacken's paper, Couper described some tents of the carton type[1]:

"An ant occurs on the Homewood estate, near Toronto, U. Canada, that constructs a kind of *papier-mâché* tent over Aphides, parasitic on a species of alder. This structure is attached to the smaller branches of the tree, generally about two or three feet from the ground. The material used by the ants appears to be fine dust fallen from the interior of decayed hard-wood trees. They convert the dust into a sort of paste which is carried up in small particles. It is wonderful to notice the steadiness and rapidity of these little architects about their work. During the cooler portions of sunny days, the whole working force (neuters) of the nest are out at labor, running up and down on the main trunk of the shrub on which the Aphides are living. Each ant in its upward course, having a small particle of the ready-made building material in its mandibles, which it adds to the structure, and the work is continued daily until the extent of the colony of Aphides is under cover. The form of structure altogether depends on the position of the Aphides. It is sufficiently open interiorly to give the ants and plant-parasites plenty of room and ventilation, and there are also several holes leading from underneath the tent for the passage of the ants. I am led to mark this form of Insect Architecture as heretofore unnoticed in America, and although sufficiently familiar with the structure, the species, which is black, and about four lines long, is unknown to me."

A more detailed description of a carton tent of *Cremastogaster lineolata* than either of the preceding was published in 1882 by Professor William Trelease[2]:

"While collecting leaf-fungi on *Andromeda ligustrina*, in a sphagnum swamp at Woods Hole, Mass., in the early part of September, 1881, my attention was attracted by a small, rough mass, apparently of dried sphagnum, surrounding one of the twigs, at a distance of about a metre and a half above the ground. Curious to know how it had reached that unusual place, and what it really was, I went to it, and on closer examination found it to be a shelter erected by a colony of about a dozen worker ants and a numerous herd of small wingless brown aphides, which feed on the sap of this plant.

"The twig on which the nest was placed had a diameter of about 3 mm., branched once at the top, and again at about 8 mm. from the bottom of the nest; between these branchlets a single leaf was given off. The nest was 3 cm. long, 1.3 cm. broad at the largest part, near the middle, tapering somewhat toward each end, where it was quite abruptly rounded off, running down the stem in a thin, solid layer for a very short distance. The walls, which had an average thickness of about 0.5 mm., also ran out in the same way, where the branchlets passed through. These decurrent portions formed the only support of the structure, which thus enclosed a capacious chamber surrounding the twig. On the inner surface, so far as seen, the wall was carefully smoothed off; the outer surface was quite irregular and rough. A small round opening existed at each end. That at the top was 3 mm. in diameter: the lower one was very minute, having a diameter of less than 1 mm. As I have said, the nest at first sight appeared to consist of dry bog-moss; a microscopic examination, however, showed the material to be chiefly small fragments of wood — evidently obtained from an old log lying at the foot of the shrub — with small quantities of the leaf-fragments of mosses and phænogams, the whole apparently glued together by the saliva of the ants. . . .

---

[1] Remarks on Tent-building Ants. Proc. Entomol. Soc. Phila., Feb. 1863, pp. 273, 274.
[2] Unusual Care ot Ants for Aphides. Psyche, Vol. III, No. 94, Feb. 1882, pp. 310, 311.

"The ants proved to be workers of *Cremastogaster lineolata* Say; not having winged individuals, I did not attempt to identify the aphides. Both, with the nest, have been placed in the biological collection of the Museum of Comparative Zoölogy at Cambridge, Mass."

In more recent years our entomologists seem to have paid little attention to the aphis-sheds of *C. lineolata*. Professor Comstock has found these structures repeatedly in the neighborhood of Ithaca, N. Y., and has kindly sent me a specimen of one of them together with a photograph of another. They are both of the earthen type and are reproduced in Figs. 1 and 2, Pl. IV. The specimen from which Fig. 1 was made is 3.5 cm. long, 2 cm. broad, and only 1.5 cm. thick. It is somewhat pyramidal in outline and has a circular opening 1.75 mm. in diameter, in its lower portion. Professor Comstock sends me the following field-notes concerning these tents: "The aphis-tents occurred upon dogwood growing on the banks of a stream. The dogwood was growing in a perfectly dry place, but only a few rods above a wet one. Although I collected these tents in several succeeding years, I never took the time to trace the ants back to their nest. The locality is a considerable distance from the University, and I visited it each year on an excursion with my class when there were many things to see, so that I had not much time to devote to these ants. These trips were made during the month of August of each year. I find one of my tents labelled Aug. 2d, '88, another

Aug. 25th, '96. On the 25th of July, '89, I found in another locality quite near the University some ant-tents built over *Kermes* on an oak sapling. This was growing in a dry place several rods from one of our streams."

Mr. E. Daecke has loaned me a fine carton tent of *C. lineolata* which he found October 23, 1903, near Hammonton, New Jersey. It is reproduced, nearly twice the natural size, in Fig. 2, Pl. III. Mr. Daecke writes me that "it was found about four feet from the ground on swamp huckleberry alongside of a wagon road. The spot, located in the typical pine-barrens, was rather moist on account of a small spring in the neighborhood."

Another tent of the carton type, but in a very dilapidated condition, was received from Mr. A. M. Ferguson, who found it near Columbia, Missouri, during the summer of 1903. This specimen, like the one mentioned by Professor Comstock, was built over some *Kermes* on an oak twig.

In the preceding paragraphs I have taken pains to bring together the scattered observations of previous authors for the reason that even in localities where *C. lineolata* abounds, it rarely constructs tents over the aphides and coccids. These structures are of local and sporadic occurrence, as if owing their origin to some unusual condition in the environment rather than to the normal instincts of the species. Though I have often sought for these structures, I have been able to find them in only one locality. August 20 and again September 5, 1905, while collecting insects in the sandy barrens about Lakehurst, New Jersey, I happened upon several fine carton tents built about the terminal twigs of some young pitch pines (*Pinus rigida*). The pines were scattered over an area of about an acre in a damp place that must have been a bog at some former time, as it was still partly overgrown with *Sphagnum* moss and studded with the stumps of larger pines destroyed by a forest fire. The *C. lineolata*, which belonged to the subspecies *pilosa* Pergande, were nesting in some of these stumps. The tents were widely scattered and probably represented the work of several colonies of ants, except in one spot where as many as fourteen were found on a single small pine only six feet high. At first sight they resembled the gray or whitish accumulations of a twig-boring tortricid caterpillar (*Retinia comstockiana* Fernald) which is destructive to the pitch pines. One of these accumulations with the hole from which the moth has escaped is shown in Fig. 1, Pl. I. Closer inspection, however, shows that the tents consist of a substance like coarse, pale gray blotting paper or dried paper-pulp. Under the microscope this resolves itself into bleached particles of *Sphagnum* moss agglutinated by some secretion from the cephalic glands of the worker ants. Several of these tents are shown in Figs. 2, 3, and 4, Pl. I, Pl. II, and Fig. 1, Pl. III. They completely envelop the terminal twigs a few inches from the tips and, though fragile, are evidently well protected from the wind and rain by the needles projecting through and a considerable distance beyond their walls on all sides. Some of the differences in the sizes and shapes of these tents are shown in the figures. The smallest specimens are 2.5 cm. long and 1 cm. in diameter, the largest 4 cm. long and nearly 3 cm. in diameter. Their walls are rarely thicker than ordinary blotting paper and as they are perforated and supported by the needles at a little distance from the surface of the twig, each tent encloses a space obstructed only by the bases of the needles, which thus answer the same purpose as the poles in a veritable tent. As a rule there is but one entrance, a circular hole about 1.5 mm. in diameter usually on one side and near the lower end of the tent, that is, the end nearer the ground or first reached by the ascending files of workers.

All of the tents contained herds of plump Coccidæ, 2–3 mm. in length, which sometimes completely covered the enclosed bark of the twig. There were also a number of *pilosa* workers busily imbibing the ejecta of their protégées or resting quietly in or among them as if loath to leave the pleasure pavilions. In Figs. 3 and 4, Pl. I, two of the tents are reproduced with a large portion of the wall removed to show the extent of the enclosed cavity, the way in which the walls are supported by the pine-needles, and the Coccidæ clustered on the bark of the twig.

The striking character of the tents described in the preceding paragraphs leads naturally to the question of their function and the study of the instincts of which they are an expression. There are several possible answers to such a question. We may suppose that *C. lineolata* builds these structures

1. for the purpose of preventing the escape of the aphides and coccids to other plants or to other parts of the same plant;

2. for the purpose of protecting these insects from their natural enemies or from other ants;

3. for the purpose of protecting them from the cold;

4. for the purpose of protecting themselves from exposure.

For some or all of these purposes the tents would seem to be most admirable contrivances. It is probable that the aphides and coccids make the same appeal to the ants' sense of ownership as their own larvæ and pupæ. This is certainly true of some other ants, like our species of *Lasius*, which are very fond of cultivating white root aphides and coccids in their subterranean galleries. Whenever the stones covering their nests are overturned, the workers seize their snowy charges in their mandibles and hurry away with them to a place of safety. It is natural, therefore, that ants should try to prevent the escape of their charges from a simple sense of proprietorship such as all ants display towards their own brood.

It is probable, moreover, that the protection of the aphides and coccids from other insects is an instinctive precaution not so much against the natural enemies of their charges, as against the larger and more powerful ants, which are quite as fond of honey dew as *C. lineolata*. This ant, being a weak and rather defenceless species, at least while foraging at some distance from its nest, must often be forced into competition with other aphidicolous and coccidicolous ants like our larger species of *Camponotus* and *Formica*. The fact that a herd of aphides or coccids is never attended by more than one species of ant at a time[1] shows that the different species of ants are quite as intolerant of one another on their feeding grounds as in their nests. It is not improbable, therefore, that *C. lineolata* in constructing tents over its charges merely emphasizes its sense of proprietorship in the presence of the larger and more powerful ants with which it has to compete in the struggle for existence; and it may well be that the tents are constructed only in localities where such competition is unusually severe.

That the tents may also serve to protect their occupants from the cold seems not to have been suggested by previous authors. Brandes[2] has shown that aphides — and the same is probably true of the coccids — are relatively inactive before dawn and do not begin to imbibe the juices of the plants till the diurnal temperature has risen sufficiently. The tents, by protecting their occupants from the cold night air, may thus prolong their feeding hours and increase the excretion of honey dew. This would, of course, be a decided advantage to the ants. In support of this supposition we may note the singular fact that the majority of authors above cited found the *lineolata* tents late in the season (August and September) and in damp localities. The cold, due to the greater evaporation in such places, coupled with the lateness of the season, would probably tend to inhibit the feeding activities of the aphides and coccids at least during the night hours. Under such circumstances a paper or earthen tent would be of great service not only to the aphides or coccids, but also to the ants themselves, since the latter feel bound to spend so much of their time in the company of their charges. This time, of course, is not misspent, since it is obviously of advantage to the ants to be on hand to prevent any waste of the honey dew.

---

[1] Except in the case of *Formica sanguinea* and its slaves, *F. fusca*, and then only when the two species belong to the same mixed colony.

[2] Die Blattläuse und der Honigthau. Zeitschr. f. Naturwiss., 66 Bd. 1893, pp. 98–103.

The tents of *C. lineolata* may seem to some to be admirable examples of foresight and reason on the part of their little builders. But although I have just shown how useful these structures may be, I am unable to maintain or even to believe that the ants are aware of these purposes. Like all ant structures, the tents undoubtedly exhibit a considerable degree of variability both in form and texture, but it is clear, nevertheless, that they are built on a common plan even in widely separated regions, so that instead of explaining them as the results of rational activity in the face of new conditions, there may be considerable justification in regarding them as due to an hereditary instinctive disposition, present in all the colonies of the species, but manifesting itself only under conditions formerly prevalent or universal but now of rare and sporadic occurrence. In order to obtain light on this matter, it will be necessary to inquire into the related instincts not only of other species of *Cremastogaster* but also of other genera of ants. In such inquiries the comparative method is of very great value. No instinct is known to be restricted to a single species, and in no two species is an instinct ever manifested in exactly the same way. Hence careful comparison of similar instincts in different species is apt to throw light on the phylogeny of animal behavior and often points the way to profitable observation and experimentation. Let us adopt this method in our study of the tent-building instincts of *C. lineolata*.

The tent-building instincts are not peculiar to the ant under discussion. In his incomparable work [1] published nearly a century ago, Pierre Huber gives the following account of the tents constructed by the "brown ant" (*Lasius niger*):

"One day I happened on a spurge plant that bore in the middle of its stem a little sphere of which the stem was the axis. This was a habitation that the ants had built of earth. They left it through a tiny opening made in its base, descended along the stem and passed into a neighboring formicary. I demolished a portion of this pavilion, built almost in the air, for the purpose of studying its interior.

---

[1] Recherches sur les Moeurs des Fourmis Indigènes. Paris, 1810, pp. 198–201.

It was a little chamber with vaulted, smooth, and continuous walls. The ants had taken advantage of the form of the plant, suspending their edifice so that the stem passed through its center while the leaves formed its only scaffolding. This retreat enclosed a numerous family of plant-lice to which the brown ants were peacefully resorting for the purpose of feeding on their ejecta in a shelter from the rain, sun, and alien ants. No insect could molest them, and the plant-lice were protected from their numerous enemies. . . .

"Several spurge stems laden with plant-lice rose from the very midst of a formicary of brown ants. These, profiting by the peculiar arrangement of the leaves of this plant, had built around each branch as many elongated chambers, to which they repaired in search of food. When I destroyed one of these domiciles, the ants straightway carried their precious animals into their nest. A few days later the structure was repaired by the insects under my very eyes and the herds were brought back to their pasture.

"These tents are not always so near the earth. I have seen one five feet above the ground, and this one merited a description. It consisted of a blackish, rather short tube surrounding a small poplar branch where it left the trunk. The ants entered it from the hollow interior of the tree in such a way that, without exposing themselves, they could reach their plant-lice by means of an opening at the very base of the branch. The tube consisted of rotten wood from the tree itself, and I saw the ants repeatedly bringing particles in their jaws in order to repair the breaches I made in their pavilion. This particular act is not very common and is not one that can be attributed to the routine of habit.

"There are also some ants that obtain their food from the plant-lice on the common plantain. These insects are usually stationed under the flower spike, but when this has faded and the stem begins to wither — and this occurs towards the end of August — the aphides retire beneath the root-leaves of the plant. Thither they are followed by the ants, which cloister themselves with their protégées by walling up with damp earth all the openings between the edges of the leaves and the ground. Then they excavate the earth underneath, in order to gain access to the aphides and be able to pass from them to their nest through covered galleries."

Huber's observations have been confirmed by Forel,[1] who has shown that in Europe tents are constructed by various species of *Lasius* (*niger*, *alienus*, *brunneus*, and *emarginatus*) and *Myrmica*

---

[1] Les Fourmis de la Suisse. Zürich, 1874, pp. 204, 205.

(*lævinodis*, *scabrinodis*, etc.). *L. brunneus* is especially devoted to attending "enormous bark aphides, which it covers with vaulted galleries made of detritus." The forms of *Myrmica* above cited "make earthen cells on plants for the purpose of covering their aphides. Some of these communicate with the nest by means of vaulted passages running along the stem, others are built freely in the air without a covered communication with the soil. It is especially the latter which with Huber we may call pavilions. The aphides, and particularly the coccids, are literally immured by the ants, although their prison is rather roomy, and the ants can enter and leave it through a little opening. I have seen a pavilion of *M. scabrinodis* situated a few centimeters above the soil on an oak branch. It was 1.5 cm. long and shaped like a cocoon. It enclosed some *Chermes* which the ants were carefully attending. When these pavilions communicate with the formicaries, the ants often carry their larvæ into them so that they become a simple dependence to the nest. I have seen a pavilion thus built about a plant stem by *Lasius emarginatus*. This pavilion also enclosed *Chermes*." Forel[1] has also observed *Brachymyrmex heeri* constructing vaulted passage-ways of vegetable débris between its nests and the coccids which it attends.

Our common American form of *Lasius niger* (*L. niger* var. *americanus*), which is very closely related to the European *alienus*, occasionally builds detritus tents around the stems of plants. One of these which I found during the past summer at Colebrook, Connecticut, is represented in Fig. 3. A small colony of *americanus*, nesting under a flat stone, was keeping aphides on a prostrate stem along which a broad and very irregular gallery had been excavated. Around the stem at the point where it emerged from under the stone, the ants had woven a cylindrical tube of fine vegetable detritus about 1½ inches in length and closed at the outer end, as if to prevent the aphides from escaping from the nest.

Both Huber and Forel have described the much larger detritus tents constructed around the stems of plants at a level with the ground by *Formica rufa*. Very similar structures are built by our fine large *F. integra*, a subspecies of *rufa*. In one locality near Colebrook I found several of these tents about the roots of some sapling paper birches (*Betula populifolia*). Two of these tents are shown in Figs. 1 and 2, Pl. VI. One of them had been built around an abandoned bird's nest which happened to occupy the center of a cluster of young trunks. Within these tents, which were about fifty feet from their formicary, the ants were guarding a few large black membracids (*Vanduzea arcuata* Say). Late in the summer, in a very different locality, near Lakehurst, New Jersey, I found a number of *integra* workers attending a herd of large lead-colored aphides on the leaves of some small oaks (*Quercus obtusiloba*) around the roots of which they had constructed tents exactly like those seen at Colebrook. The ants had evidently been keeping aphides or membracids in these tents earlier in the season.

---

[1] Études Myrmécologiques en 1875. Bull. Soc. Vaud. Sc. Nat., XIV, 1875, pp. 39, 40.

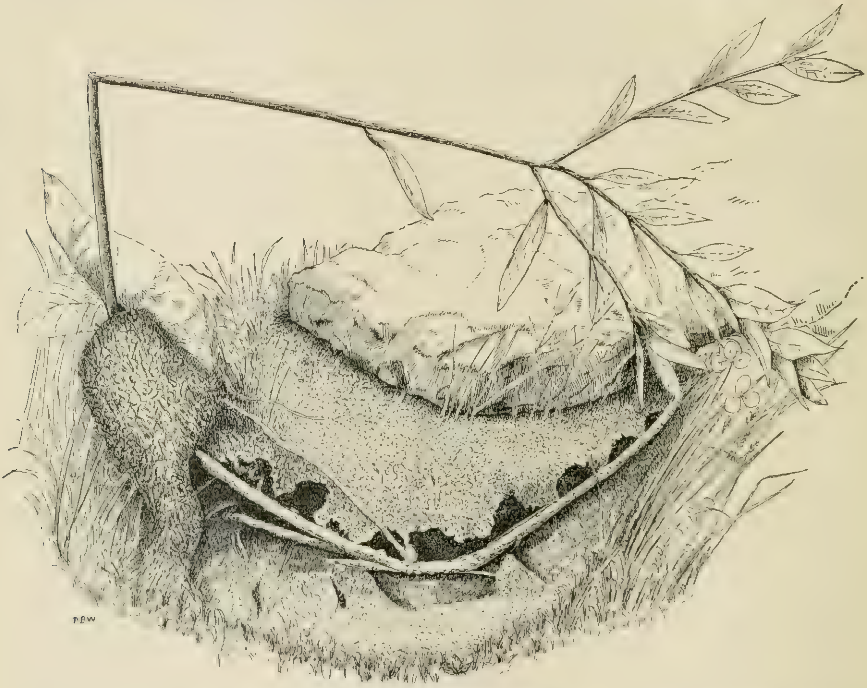


Fig. 3. Nest of *Lasius niger* L. var. *americanus* Emery under stone. The stone has been removed, showing a prostrate plant-stem along which the ants have constructed an irregular gallery. An aphis tent of vegetable detritus is shown on the left-hand side of the figure where the plant-stem rose from under the stone.

F. rufa and its subspecies *integra* may be regarded as typical of a large number of species and genera of ants and show very clearly the intimate connection between the construction of tents and that of the nest proper. The tents are, in fact, merely detached portions of the nest set aside for a particular purpose. Ants are apt to be regarded as mere excavators in soil or wood and their mounds as mere accumulations of the excavated materials. While such a view truthfully represents the conditions in certain species, it is, nevertheless, a very partial view of the nesting instincts of ants in general. For in addition to the excavation of galleries and chambers, the workers of many species, like *F. rufa*, range far afield in search of vegetable débris such as twigs, bits of dead grass, leaves, pine-needles, pellets of earth, etc., and with these construct large mounds, in which the young can be more rapidly incubated than in the cold soil. These building instincts, which may be called positive and centripetal as distinguished from the negative and centrifugal excavating instincts, are so widely distributed among ants as to suggest very forcibly that the primitive ancestral forms of the family must have been architects like the wasps and bees, working the soil or vegetable débris up into rude nests and attaching them to plants and the sides of stones. From such a condition a great number of species have lapsed into mere excavators of the soil, a change the more easily accomplished because the under surfaces of stones and logs furnish such excellent roofs for their galleries and chambers as to render the constructive instincts superfluous. Whether this has been the universal tendency in the Formicidæ can be decided only after further investigation. That it has been the tendency in the genus *Cremastogaster* appears to be satisfactorily shown by the following observations.

The most elaborate and perhaps the most primitive form of architecture among ants is found among the species that use carton in the construction of their nests. These species are members of the genera *Camponotus*, *Polyrhachis*, *Lasius*, *Azteca*, *Liometopum*, *Dolichoderus*, and *Cremastogaster*, and represent three of the five subfamilies of ants. The carton-building species of *Cremastogaster*, with which alone we are here concerned, are nearly all confined to the tropics. As they are distributed over both hemispheres, however, we may infer that the instinct to agglutinate vegetable detritus, dried cow-dung, etc., and build it up into the form of spherical or subspherical nests, is fundamental and of long standing in the genus. Among the Indian species, these carton nests, which are suspended to the branches of trees like the nests of certain hornets in more northern latitudes, were long ago described and figured by Sykes[1] for *C. kirbyi*. Kirby has reproduced Sykes's figures in the Seventh Bridgewater Treatise.[2] Later Mayr, Wroughton, and Rothney called attention to similar habits in two other Indian species (*C. rogenhoferi* and *ebeninus*).[3]

---

[1] Descriptions of New Species of Indian Ants. Trans. Ent. Soc. London, I, 1836, pp. 99–103, pl. xiii, fig. 1.

[2] On the Power, Wisdom, and Goodness of God as Manifested in the Creation of Animals and in their History, Habits, and Instincts. Second Am. Edit., Phila., 1837, pl. xi.

[3] *Mayr*, Beiträge zur Ameisenfauna Asiens. Verhandl. k. k. Zool. bot. Gesell. Wien, 1878, pp. 39, 40; *Wroughton*, Our Ants. Journ. Bombay Nat. Hist. Soc., 1892, p. 23; *Rothney*, Notes on Indian Ants. Trans. Ent. Soc. London, 1895, Pt. II, p. 205.

Another species (*C. artifex*), according to Mayr,[1] builds paper nests in Siam and Singapore. In Madagascar *C. ranavalonæ* Forel builds spherical carton nests 3 dcm. (1 foot) in diameter and *C. tricolor* of the same island has a very similar habit.[2] In Africa no less than three species (*C. inconspicua*, *margaritæ*, and *stadelmanni* var. *intermedia*) have been shown by Mayr and Aurivillius to construct large paper nests.[3] These authors describe an *intermedia* nest that was 68 cm. long, 37 cm. broad, and 80 cm. in circumference.

In tropical America there are several carton builders among the species of *Cremastogaster*. F. Smith long ago figured the paper nests of the Mexican *C. montezumia*[4] and Forel has more recently shown that similar structures are made by *C. sulcata*, its variety *ramulinida* and *C. stolli* in Central America and Colombia.[5] *C. stolli* also makes long vaulted galleries which wind about on the tree trunks and along the small branches in the thickets. The ants move about in these galleries and rarely expose themselves to the open air. This species is of particular interest in connection with the tent-building habits of *C. lineolata*.

Turning from these strictly arboreal species of *Cremastogaster*, we are led to inquire whether there are any indications of the carton-building instinct in the terrestrial species like *C. lineolata*. McCook several years ago briefly described the nesting habits of this ant as follows[6]: "The favorite nesting place is under stones or underneath and within the decayed matter of old logs and stumps. This material is sometimes prepared by the ant as a paper-like pulp, and arranged into cells and chambers, which are attached to the surfaces of logs." Similar carton constructions are often built under stones. Fig. 4, Pl. IV, shows the surface chambers of a large *C. lineolata* nest found under a stone in a pasture near Colebrook, Connecticut. In the center of the figure, to the left of the main opening leading into the subterranean galleries, there is a large chamber containing pebbles and traversed by a branching rootlet which is covered with irregular masses of black carton. In other nests somewhat greater accumulations of this substance are occasionally found.

In a variety of *lineolata* not uncommon in the mountains of Colorado at an altitude of 6000 to 7000 feet, where the scrub oaks grow among the red volcanic rocks, I have found a much greater tendency to construct masses of carton in the nests under stone. One of these masses of about ¾ the natural size is shown in Pl. V. A stone had rolled down on to a lot of dead oak leaves and the spaces between these had been built into a series of inosculating and slightly concentric chambers by means of black carton partitions carried up to the lower surface of the stone. In other nests the pebbles or twigs on which the stone happened to lie were similarly covered with irregular masses of carton. A fragment of this material from such a nest is shown in Fig. 3, Pl. IV. In all these cases the surface of the carton was covered with a delicate blue mould which probably derived its nutriment from the glandular secretion used by the ants as a mortar in agglutinating the fine particles. A similar mould has been observed by Lagerheim [1] covering the carton plates in the nests of the European *Lasius fuliginosus*, and is said to be eaten by the ant-larvæ. In the case of the Colorado *lineolata*, the layer of mould would be an entirely inadequate food supply for the thousands of larvæ found in one of these nests, and there is nothing to indicate that it is of the slightest use to the ants. The blackness of the carton in these nests is due to the large amount of soil used in its construction.

---

[1] Loco citato, pp. 40, 41.

[2] *Crandidier.* Histoire Physique, Naturelle et Politique de Madagascar. XX Hymenoptères, 2. Partie. Les Formicides par A. Forel, 1891, pl. vii.

[3] *Mayr, G.* Beiträge zur Kenntniss der Insektenfauna von Kamerun. Formiciden. Entomol. Tidskr., Årg. 17, H. 3, 1896, pp. 253–255. Taf. 4, 5.

[4] Catalog. Hymenopt. Insects, in Coll. Brit. Mus., Pt. VI, Formicidæ, 1858, pl. i.

[5] Biol. Centrali-Amer., Hymenoptera, Vol. III, Formicidæ, 1899–1900, pp. 83, 84, pl. ii, figs. 1 and 2. The nest of *C. sulcata* is also described by Emery in his Studii sulle Formiche della Fauna Neotropica. I, Bull. Soc. Ent. Ital., XXII, 1890, p. 53.

[6] Formicariæ in Comstock's Report upon Cotton Insects. Washington, 1870, p. 188.

It is difficult to understand why the ants build masses of carton in these nests under stones unless they are exhibiting a merely vestigial instinct which may be called into activity whenever they find leaves or twigs — the very objects about which their arboreal ancestors built carton nests — in the way while they are excavating. The covering of the rootlets with carton in the Colebrook nest above described may also be taken to indicate that contact with vegetable surfaces acts as a stimulus to which the ants respond with an ancient and abortive instinct. This response may, however, assume extraordinary proportions in *lineolata* colonies that are compelled to return to a strictly arboreal life like their tropical ancestors, as shown in the following observation published several years ago by Atkinson [2]:

"The nest was built several feet from the ground on a bush, in the marshes bordering Broad Creek, Hyde County, N. C. . . .

"This nest is about eighteen inches long by twelve inches in circumference at its greatest diameter. I made a longitudinal section of it, and had a photograph taken, so as to represent both the external form and internal structure. The ants were alive in the nest when I received it. They were chloroformed before sectioning the nest. I took from the nest about one-fourth pint of adults, pupæ and larvæ. They were collected in a mass through the chambers within a space four inches in length of the nest. This space is about two-thirds the distance from the lower end. The material composing the cells in this space is lighter in color than the other internal parts. . . .

---

[1] Ueber Lasius fuliginosus (Latr.) und seine Pilzzucht. Entomol. Tidskr., Årg. 21, pp. 17–29, 4 figs.

[2] Singular Adaptation in Nest-Making by an Ant, *Cremastogaster lineolata* Say. Am. Naturalist, Vol. XXI, 1887, pp. 770, 771, pl. xxvi.

"The material used in making the nest seems to be the same as that used by the ant in making its nest under stones, etc. Beside the woody pulp, a microscopic examination seems to reveal also some portions of dried grass. The nest is supported by the branches of the bush; a vine and some stalks of marsh-grass are fastened in it. Upon the outside the material is of a light gray color, much like that of the nest of the white-faced hornet. In the interior it is darker, in some places almost black. Probably the high tides, causing the creek to overflow, forced the ants to build their nest above the high-water mark instead of under stones and within logs."

In this exceptional instance, as shown by the figure accompanying Professor Atkinson's article, the ants had constructed a large carton nest of the same kind as the tropical species above mentioned. We may regard this occurrence as an interesting case of atavism and as demonstrating that instincts like structures may become latent and manifest themselves with almost pristine intensity after an apparent disappearance during many generations. Such conditions, which are apt to prove embarrassing when the potential aspects of instinct are ignored and only its manifestation as "instinct action" is taken into consideration, lead inevitably to the assumption of "dispositions" in the sense in which this term is used by some modern human psychologists.[1]

An explanation of the tents of *C. lineolata* is to some extent implied in the preceding consideration of the carton-building instinct of this species. They may obviously be regarded as small but detached portions of the nest, constructed in a specific environment which at one time, in the possibly not very remote phylogenetic history of the species, led to the building of carton nests. The worker ants, finding themselves detained by their strong appetite for honey dew in exposed situations on the stems of plants, build these small succursal nests, primarily, perhaps, for their own comfort and protection, but at the same time admirably suited to a number of other purposes, as I have shown on p. 7. The presence of the aphides and coccids must also act as a stimulus akin to that which is exercised by the presence of larvæ and pupæ, in calling forth as a response the protective and philoprogenitive, and hence also the nest-building instincts of the species. Originally the tents may have been connected with the main nest by covered galleries such as are still built by *C. stolli*, *Brachymyrmex heeri*, some of the species of *Formica* of the *rufa* group, and many termites, as a means of avoiding exposure to light and enemies. Sometime it may be possible to test the truth of these conclusions experimentally by isolating and exposing colonies of *C. lineolata* on the stems of plants within depriving them of an abundant supply of food and the materials from which carton can be made.

---

[1] These cases of the revival of instincts are particularly suggestive in connection with Hering's view recently elaborated by Semon in his interesting volume "Die Mneme als erhaltendes Prinzip im Wechsel des organischen Geschehens." Leipzig, Wilhelm Engelmann, 1904.

EXPLANATION OF PLATES I–VI.

PLATE I.

FIG. 1. — Accumulation of resin on twig of pitch-pine (*Pinus rigida*) produced by the boring caterpillar of a Tortricid moth (*Retinia comstockiana* Fernald). x 1¾.

FIG. 2. — Carton coccid-tent built by *Cremastogaster lineolata pilosa* Pergande around a twig of pitch-pine, exposed by cutting away part of the needles and showing the opening through which the ants enter and leave the tent. x 1½.

FIGS. 3 and 4. — Similar tents cut open to show the coccids on the twigs and the way in which the carton walls are supported by the pine needles. x 1½.

PLATE II.

A carton coccid-tent built by *Cremastogaster lineolata pilosa* around a twig of pitch-pine. x 1½.

PLATE III.

FIG. 1. — Unusually large coccid-tent built by *Cremastogaster lineolata pilosa* around a twig of pitch-pine, showing the entrance near the base of the lower branch on the right side. x 1½.

FIG. 2. — Carton aphis-tent built by *Cremastogaster lineolata* on twig of swamp huckleberry. x 1¾. From a specimen in the collection of Mr. Erich Daecke.

PLATE IV.

FIG. 1. — Earthen aphis-tent built by *Cremastogaster lineolata* on dogwood. x 1½. From a specimen collected by Professor J. H. Comstock near Ithaca, N. Y.

FIG. 2. — Similar tent, natural size From a photograph made by Professor Comstock.

FIG. 3. — Piece of black carton built over twigs under a stone by a Colorado variety of *Cremastogaster lineolata.* ¾ natural size.

FIG. 4. — Surface chambers of nest of *Cremastogaster lineolata* under a large stone, showing black carton covering rootlets. ⅕ natural size.

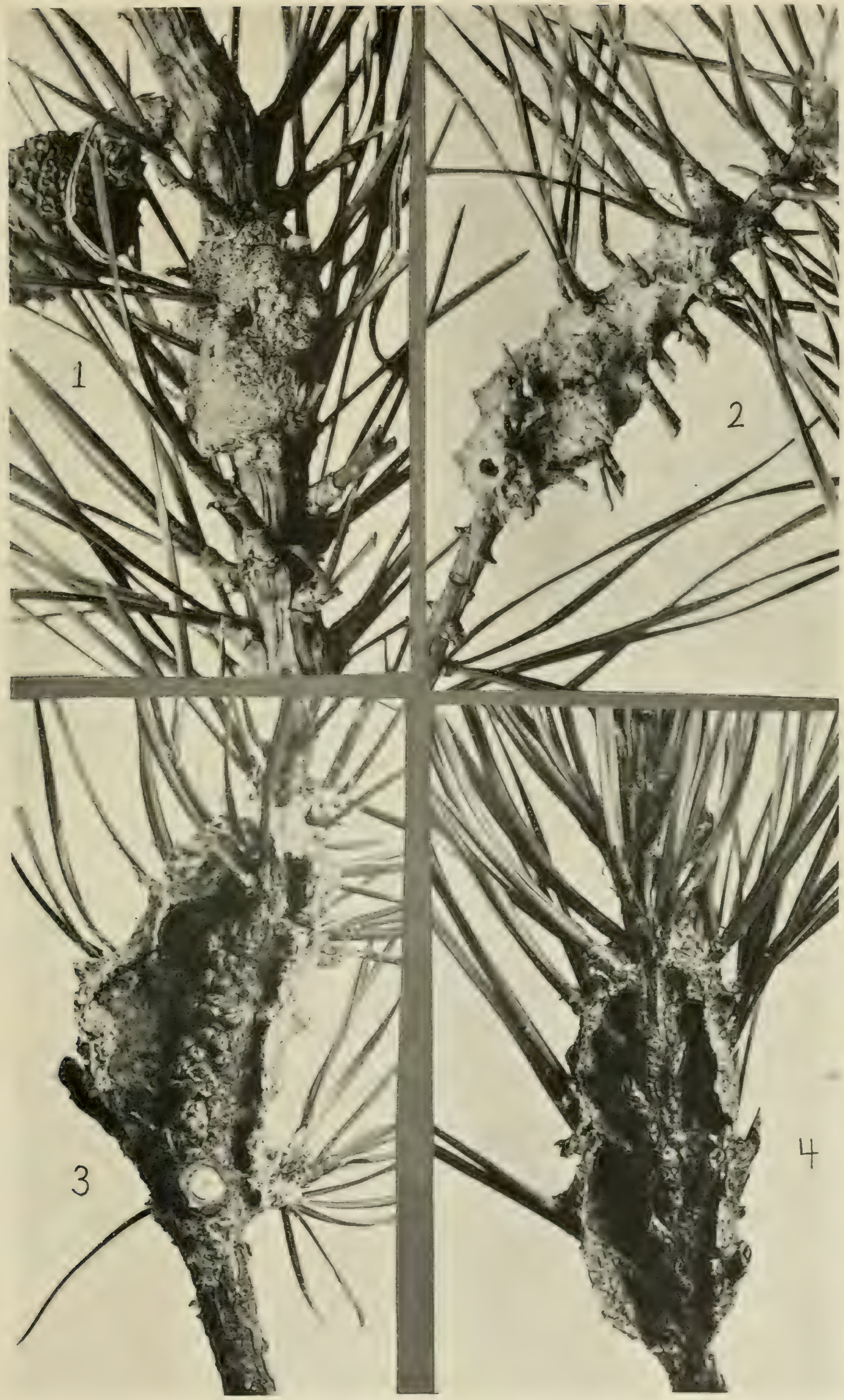
PLATE V.

Nest of a Colorado variety of *Cremastogaster lineolata* built of dead oak-leaves and black carton under a stone. ⅔ natural size.

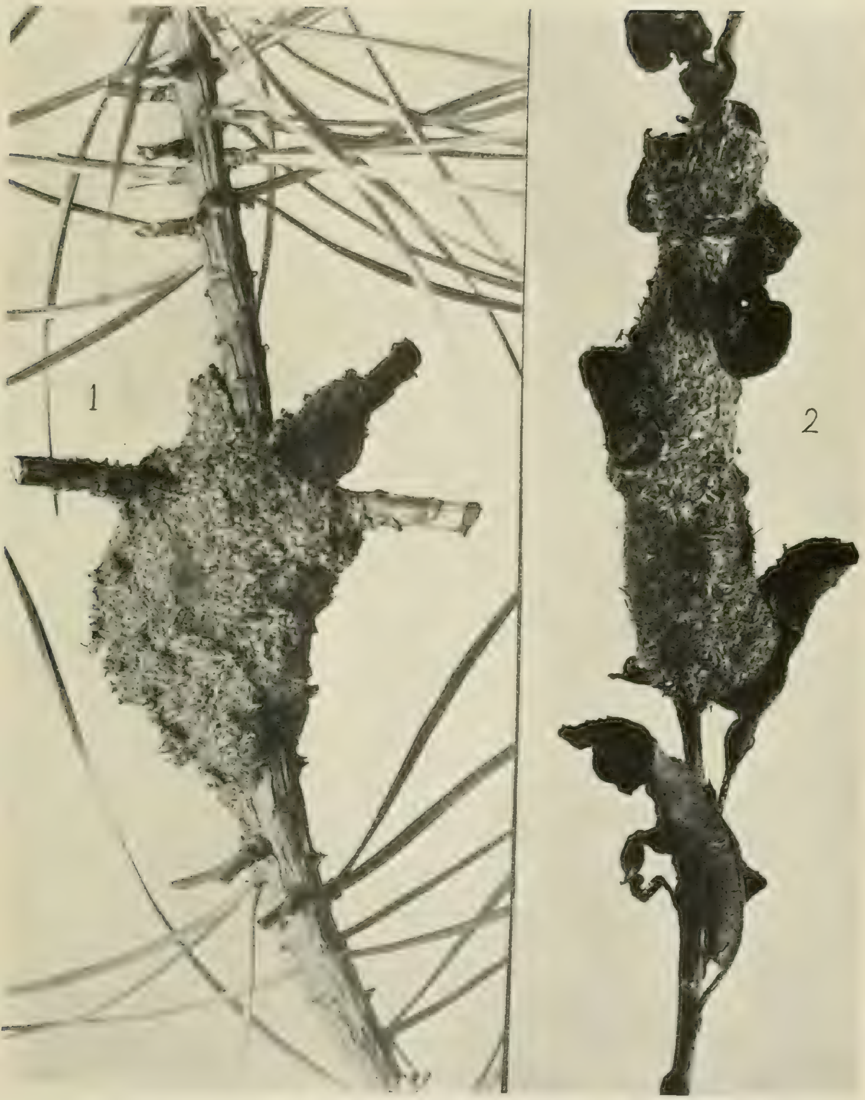
PLATE VI.

FIG. 1. — Membracid-tent of *Formica rufa integra* Nyl. built about the roots of a young birch (*Betula populifolia*). ½ natural size.

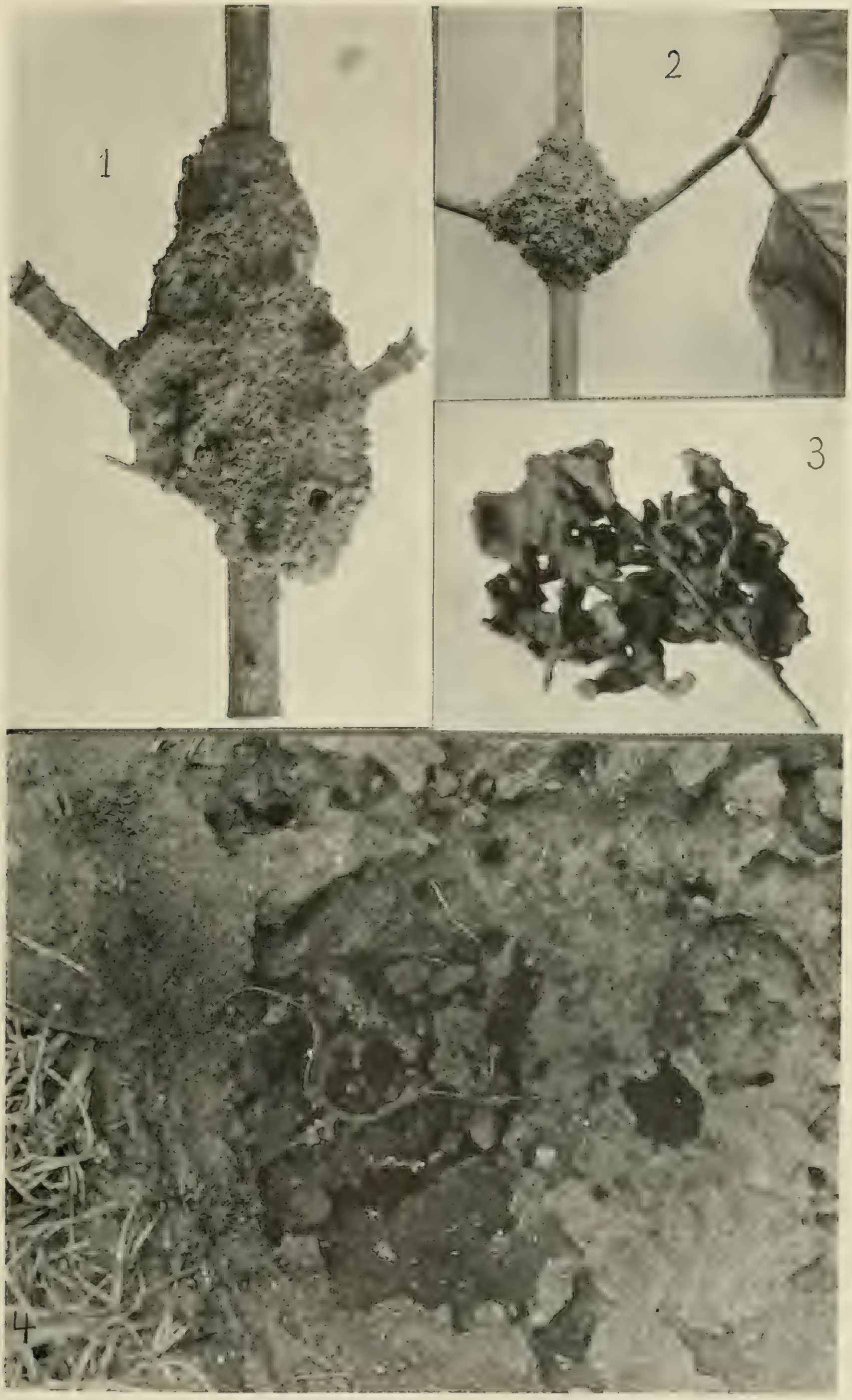
FIG. 2. — Similar tent built around a bird's nest. ⅕ natural size.



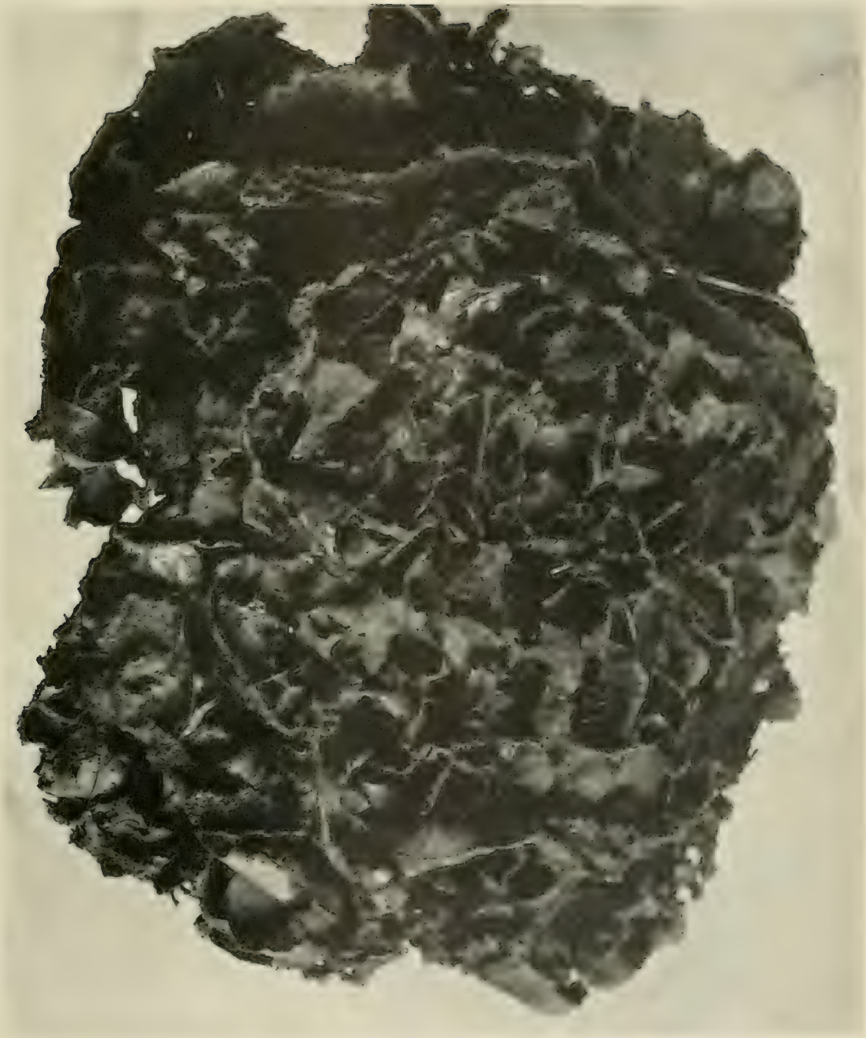
CARTON COCCID-TENTS OF CREMASTOGASTER LINEOLATA PILOSA PERGANDE.



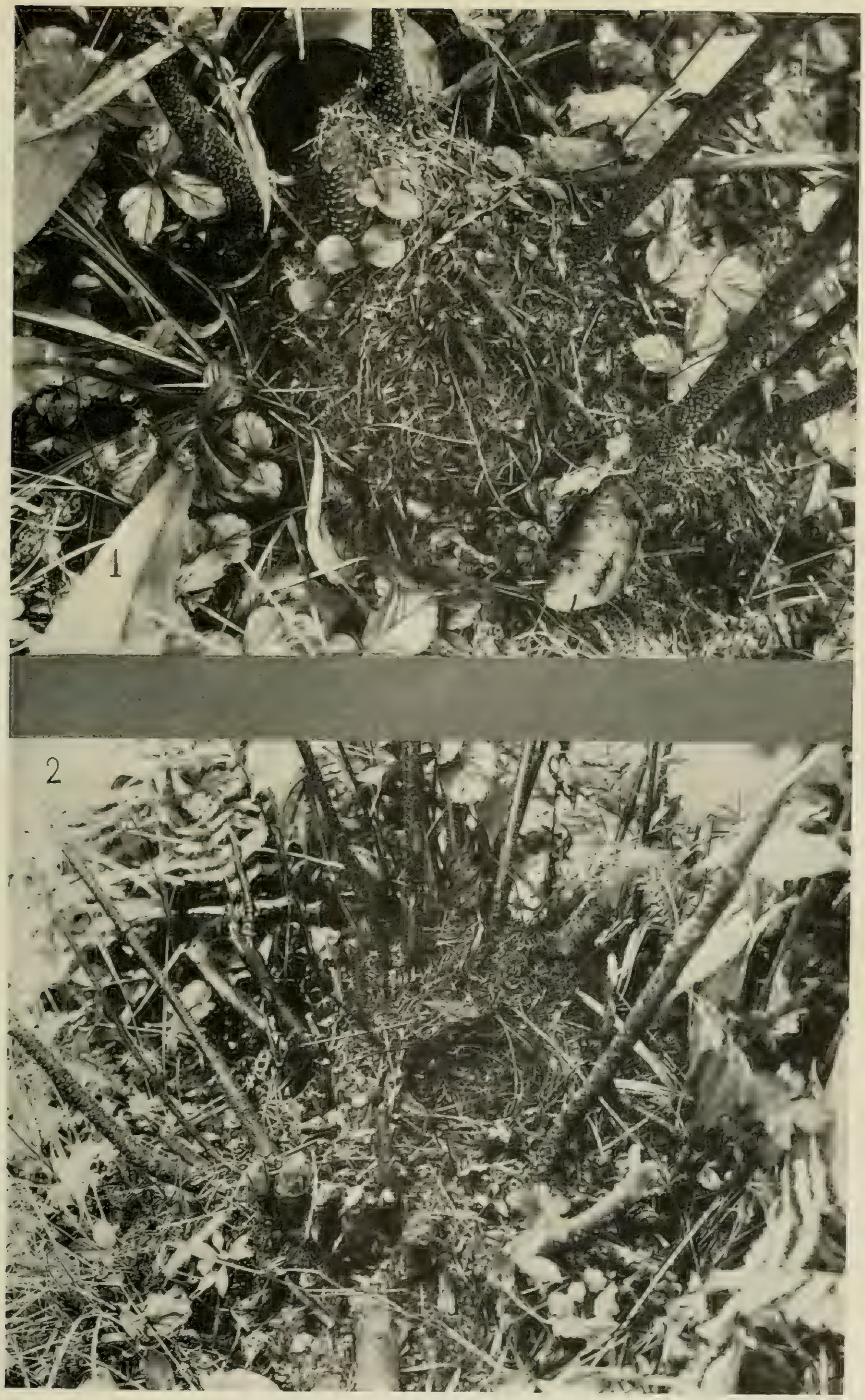
Carton Coccid- and Aphis-tents of Cremastogaster lineolata Say.



Earthen Aphis-tents and carton constructions of Cremastogaster lineolata Say.



CARTON NEST OF CREMASTOGASTER LINEOLATA SAY, VAR.



MEMBRACID-TENTS OF FORMICA RUFA INTEGRA NYL.

56.81, 7 E : 14.71, 5

Article II. — ON THE SKULL OF EDAPHOSAURUS POGONIAS COPE.

By E. C. Case.

Plate VII.

The description of the skull of *Edaphosaurus* is a portion of a larger work on the Pelycosauria in course of preparation by the author. The work was carried on by aid of a grant from the Carnegie Institution of Washington and is published in advance of the completed work by the permission of the Institution.

The skull is the property of the American Museum of Natural History, forming a part of the Cope Collection, and was placed at my disposal for description by the Curator of Vertebrate Palæontology, Professor H. F. Osborn, to whom my thanks are due.

Family Edaphosauridæ *Cope.*

Proc. Am. Phil. Soc., Vol. XX, 1882, p. 450. Also Pal. Bull. 35.
Proc. Am. Phil. Soc., Vol. XX, 1883, p. 631. Also Pal. Bull. 36.

Type:—A nearly complete skull with the lower jaw of the left side and the imperfect axis. No. 4009, Am. Mus. Nat. Hist. Cope Coll. From Texas.

In his Systematic Catalogue of the Vertebrates of the Permian Formations of North America, published in 1888, Cope abandoned this family, placing the genus in the family Clepsydropidæ. It is here restored for reasons that appear in the text below.

Genus **Edaphosaurus** *Cope.*

Proc. Am. Phil. Soc., Vol. XX, 1882, p. 448. Also Pal. Bull. 35.
Trans. Am. Phil. Soc., Vol. XVII, 1892, pp., 15 l. xi, figs. 5 and 5a.

Description of the Family and Genus: — Aberrant Pelycosaurs, littoral or estuarine in habit; feeding upon molluscs and crustaceans. Skull low, wide posteriorly, and tapering to the anterior end. A large superior temporal foramen, and, probably, a smaller inferior one. Interparietal and epiotic present. Incisor teeth approaching chisel-shape; anterior maxillary teeth broadly triangular and thin with anterior and posterior cutting edges; posterior maxillary teeth conical; posterior teeth of the lower jaw all conical. On the pterygoid and palatine and on the dentary large patches of stout crushing teeth.

The specimen of *Edaphosaurus pogonias* Cope is unique, nothing identifiable with it occurring in any other collection from the Permian of North America. The depressed form of the skull and the suggestion of the axis that the vertebræ were low and broad indicate affinities with the Cotylosauria, but the temporal region with its enormous superior temporal vacuity and almost certain inferior vacuity as well indicates affinities with the Pelycosauria. As the condition of the temporal arches is of more fundamental importance than that of the shape of the skull and the vertebræ, the animal is referred tentatively to the Pelycosauria, family Edaphosauridæ. Its habits of life must have been very similar to those of *Placodus* and if future discoveries should show that it really possessed a single temporal vacuity or that the inferior vacuity was decadent, the kinship of *Edaphosaurus* with *Placodus* as an ancestral form would be strongly suggested.

The *skull* is roundly triangular and flattened above; the temporal region is elevated and the upper surface descends in an almost straight line to the anterior end. The external nares are small and nearly terminal but open laterally. The orbits are of moderate size and look nearly straight outwards. The dentition is very peculiar, varying from chisel-shaped incisors to thin, triangular cutting teeth in the anterior portion of the maxillary and conical teeth in its posterior portion.

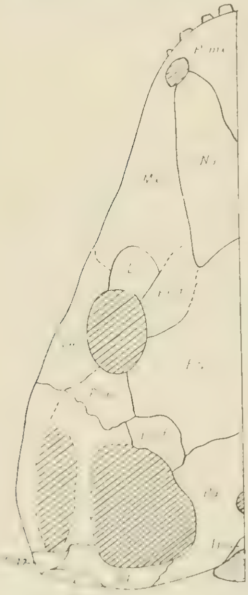


Fig. 1.

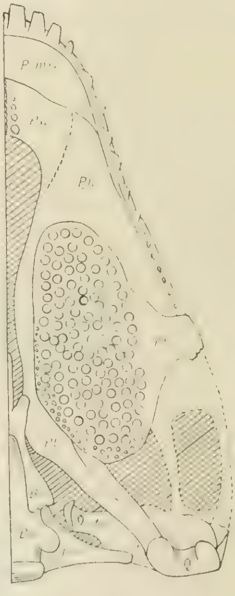


Fig. 2.

Fig. 1.—Diagram of the upper surface of the skull of *Edaphosaurus*. x $\frac{1}{2}$. *P.mx.* premaxillary, *Na.* nasal, *Mx.* maxillary, *L.* lachrymal, *Prf.* prefrontal, *Ju.* jugal, *Fr.* frontal. *Po.f.* postfrontal, *Po.o.* postorbital, *Pa.* parietal, *Ip.* interparietal, *Sq.* squamosal, *Psq.* prosquamosal, *Qj.* quadratojugal. x $\frac{1}{2}$.

Fig. 2. Lower surface of the same. *P.v.* prevomer; *P.l.* palatine; *P.t.* pterygoid; *stp.* stapes; *Bo.* basioccipital; *Bs.* basisphneoid: *p.oc.* paroccipital. x $\frac{1}{2}$.

The *premaxillary* is short and relatively broad but with a long posterior prolongation in the median line which extends back to join the nasals. There are four teeth in each premaxillary which are badly worn but were apparently furnished with a strong terminal cutting edge something like that of the modern rodents, or the ancient *Placodus*. The teeth projected slightly forward from the alveolar edge.

The posterior edge of the bone forms the anterior edge of the nares.

The *maxillary* is a broad plate extending upward somewhat obliquely and uniting with the nasals above and the premaxillary anteriorly. The anterior edge forms the posterior edge of the nares and the posterior end lies below the middle of the eye socket. There are fourteen teeth in the bone; the anterior five are thin triangular plates that originally had well developed anterior and posterior cutting edges but these have been largely destroyed by decay. The posterior nine teeth are conical. All the teeth are in sockets and rest against the outer edge of the bone, which descends lower than the inner.

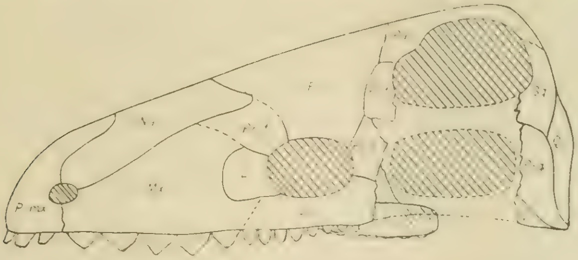


Fig. 3.—Diagram of the lateral view of the skull of *Edaphosaurus*. Lettering the same as in figure 1. x ½

The *nasals* are broad flat plates embracing the premaxillaries anteriorly and extending between the frontals posteriorly.

The *frontals* are very broad and flat; they meet the parietals posteriorly in a wide suture and form the major portion of the upper edge of the orbit.

The *prefrontals* form the upper anterior corner of the orbit.

The *lachrymals* are short bones, rounded anteriorly and extending back on the floor of the orbit to the anterior third of the lower edge.

The *parietals* are flat anteriorly with a good-sized parietal foramen but the posterior portion is somewhat convex. The bones of the two sides meet in a slight depression so that the crown of the skull is arched antero-posteriorly and depressed in the midline. The outer edge is concave and forms the upper border of the superior temporal vacuity. From the posterior outer corner a process curves gently outward and downward to unite with the squamosal.

The *interparietal.* Between the parietals posteriorly is a small diamond-shaped bone which extends downwards beyond the parietals and separates the pair of bones below.

The *postfrontal* is represented by a fragment of bone between the frontal and parietal whose posterior edge forms the anterior edge of the superior temporal vacuity; the lower edge is missing.

The *postorbital* and *jugal* are not distinct.

The *quadrate* resembles that of the other Pelycosauria; the upper portion is thin and plate-like and the lower end carries two large condyles, the outer somewhat more posterior than the inner. The long axis of the condyles is inclined somewhat inward. The outer condyle is extended backward as in *Dimetrodon*, forming a sort of shelf on which rests the lower end of the quadratojugal.

The *quadratojugal* and *prosquamosal* occupy the same relative positions as in *Dimetrodon*. The first rests against the posterior edge of the quadrate and overlies the posterior edge of the prosquamosal. There are indications that a quadrate foramen was present but it is closed in the specimen, perhaps by pressure. Superiorly the quadratojugal passes below the lower ends of the squamosal and a second bone, the epiotic (?). The anterior end of the prosquamosal is broken away, but it reaches up as far as the upper edge of the quadrate touching the lower end of the squamosal.

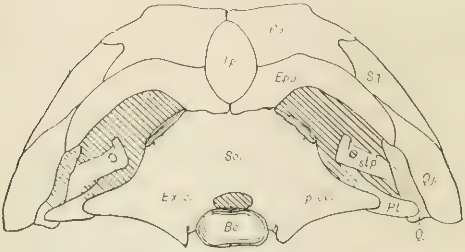


Fig. 4.—Posterior view of the skull of *Edaphosaurus*. Lettering the same as in figure 1. *Ex.o.* exoccipital, *So.* supraoccipital, *Epo.* epiotic. x ½.

The *squamosal* is a thin and slender element, convex in curvature, which joins the parietal above and the quadratojugal and the prosquamosal below. At its lower end a wide process started forward toward the postorbital, but this is broken so that its anterior connections cannot be made out. The process evidently is a portion of a bridge across the temporal vacuity; Cope considered that there was but one such bridge and that the animal had a single temporal arch, but the condition of the specimen makes probable the presence of a second arch below.

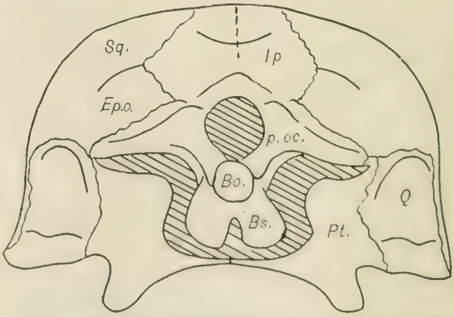


Fig. 5.—Posterior view of the skull of *Placodus*. After v. Huene. Lettering the same as in figure 1.

Epiotic (?).—This is the element referred to by Cope as "perhaps a transverse process of the supraoccipital." Below the parietal and interparietal and above the posterior wall of the cranial cavity is a pair of slender curved bones; lying next to the lower edge of the squamosal they extend outward and downward until they touch the upper ends of the quadratojugal. These bones are in the exact position of the epiotics and there is little doubt that they are homologous with the same bones in the Cotylosauria and Stegocephalia. They do not occur in the other families of the suborder. The name epiotic was originally used for a different element ; it is here used for the element so called by Cope in Cotylosauria.

The posterior surface of the cranium is formed by a single mass of bone, the sutures between the *basioccipital*, *supraoccipital*, *exoccipitals*, and the *paroccipitals* are not distinguishable. The plate is partly obscured in the specimen by the crushing which has forced the parietals with the interparietal and the epiotics down over it as far as the foramen magnum. The paroccipital processes extend outward nearly to the quadrate. The occipital condyle is relatively broad and oval in outline, with no pit marking the position of the anterior end of the notochord.

The *basisphenoid* has the same form as in *Dimetrodon* but is relatively longer. It has a strong parasphenoid process, well developed articular faces for the pterygoids, and a large pit on the lower surface.

The *stapes*.—On either side of the basisphenoid is a short, wide bone which occupies the position of a stapes. The inner end is smaller but terminates in a flat surface; just below the extremity the bone is pierced by a foramen.

The *palate* is well preserved on one side. There is a great median vacuity forming the posterior nares but there are no palatal vacuities. The sutures between the pterygoids, palatines, and prevomers cannot be made out.

The *prevomers* are thin plates connecting anteriorly and laterally with the premaxillaries and anteriorly with each other; more posteriorly they are cut out on the median line so that when the two were in position there was an elongate heart-shaped vacuity in the median line. At the anterior end where the two bones meet there are four conical teeth on each bone; the posterior is the larger.

The *pterygoids* articulate with the basisphenoid in the midline and send a strong process backward which articulates with the inner side of the lower end of the quadrate. There is no descending external process forming a buttress for the lower jaw as in the other Pelycosauria. The line of union with the palatine cannot be made out.

Covering a large portion of the pterygoid and the palatine is an oval plate studded thickly with stumpy conical teeth irregularly arranged. On the inner edge there are some teeth of smaller size. Most of the teeth are injured by decay but it can be seen that the ends were very blunt, resembling the pharyngeal teeth of *Labrus*. The plate bearing the teeth is very heavy and extends backwards underlying the anterior half of the temporal region.

The *lower jaw* of the left side is nearly perfectly preserved. The sutures between the separate bones cannot be made out. The anterior symphysis is very strong and was formed by the splenial as well as the dentary. There are twenty counted teeth and alveoli and there were perhaps three or four more at the posterior end. The anterior teeth are similar to the premaxillary teeth above but there are none corresponding to the triangular teeth of the anterior portion of the maxillary; all are conical, growing smaller toward the posterior end. The alveolar edge is somewhat elevated. In the posterior half of the jaw is a dentigerous plate corresponding in size and shape to the pterygoid plate above and studded with the same kind of teeth. It is probably supported largely by the dentary but the splenial may also take part. The articular region has two cotyli corresponding to the condyles of the quadrate above. There are no openings on the outer side of the jaw and none can be made out on the inner side.

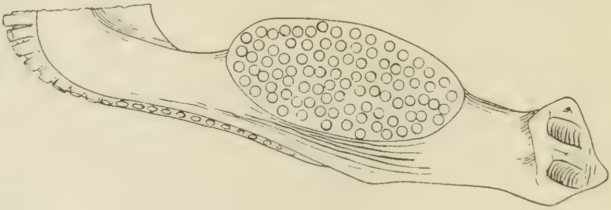


Fig. 6.—Lower jaw of *Edaphosaurus*. x ½.

The *axis* has a short centrum with elongate pits on either side as in *Naosaurus*. The transverse processes rise from the neural arch and the upper edge of the centrum; the posterior edge is continued as a long ridge on the side of the centrum to the posterior edge. The anterior face is elongate vertically but it has been crushed so that the form is obscured. The spine is low but it was very heavy, curving forward over the anterior face; the posterior zygapophyses are large but the anterior ones are small The posterior edge of the spine is very wide, extending out over the sides of the centrum.

Position and Relationships.—It is most unfortunate that the vertebræ and limbs of this form are not known. The evidence of the skull shows that it has little in common with the rest of the Pelycosauria and that it is very far removed from the genus *Naosaurus* with which it was most closely connected by Cope. The probable similarity of habits to *Placodus* has been pointed out above and a comparison of the skulls shows many points of resemblance. These are best shown in a comparative table:

Placodus.	*Edaphosaurus.*
Skull low and broad.	Skull low and broad.
A single temporal vacuity.	Probably two temporal vacuities.
Incisor teeth chisel-shaped. projecting forward from the skull.	Incisor teeth approaching chisel-shape and projecting forward from the skull.
Maxillary teeth flat and adapted to crushing or grinding.	Maxillary teeth thin and sectorial.
Posterior nares a single opening between the prevomers and premaxillaries.	Posterior nares a single opening between the prevomers.
Palatine teeth few and large.	Palatine teeth numerous and smaller.
Teeth of the lower jaw reduced to the incisors and crushing teeth.	Lower jaw with teeth on the border as well as the crushing teeth.
Pterygoid without external process.	Pterygoid without external process.
Interparietal and epiotic present.	Interparietal and epiotic present.
Occurring in the Triassic.	Occurring in the Permian.

There is not sufficient evidence to warrant the conclusion that there is an actual relationship between *Edaphosaurus* and *Placodus*, but the similarity of the two is certainly very suggestive. If *Placodus* is a true synapsidan form, related to the Anomodonts as held by many authors, it could have no connection, genetically, with *Edaphosaurus*, but it must have passed through a similar stage of evolution in the growth of the palatine and dentary crushing teeth and the loss of the teeth on the edges of the maxillary and the dentary. Two things are worthy of note in the study of the relations of the two: (1) It is not proven that *Edaphosaurus* had two temporal vacuities, though I believe it to have been the case. (2) The new genus *Anomosaurus* of v. Huene, which he believes to be a Pelycosaurian and which is certainly very closely related to that suborder, comes from not only the same horizon but even from the same locality as *Placodus*,[1] and some of the vertebræ, at least, may belong to it. Should this turn out to be true it may be that future discoveries will show that *Edaphosaurus* occupies an ancestral position to the Placodontia.

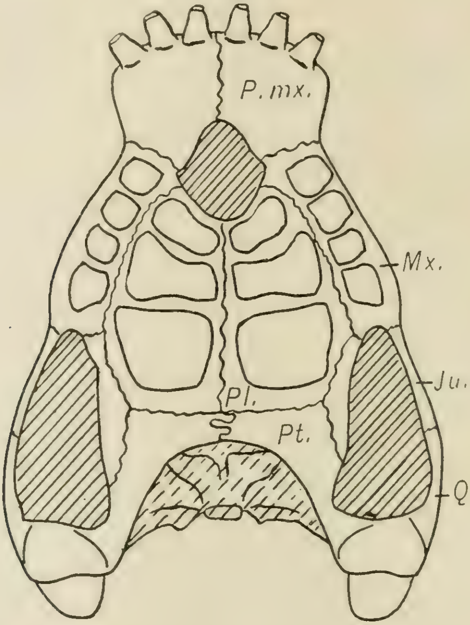


FIG. 7.—Palatal view of the skull of *Placodus*. After v. Huene. Lettering as in figure 2.

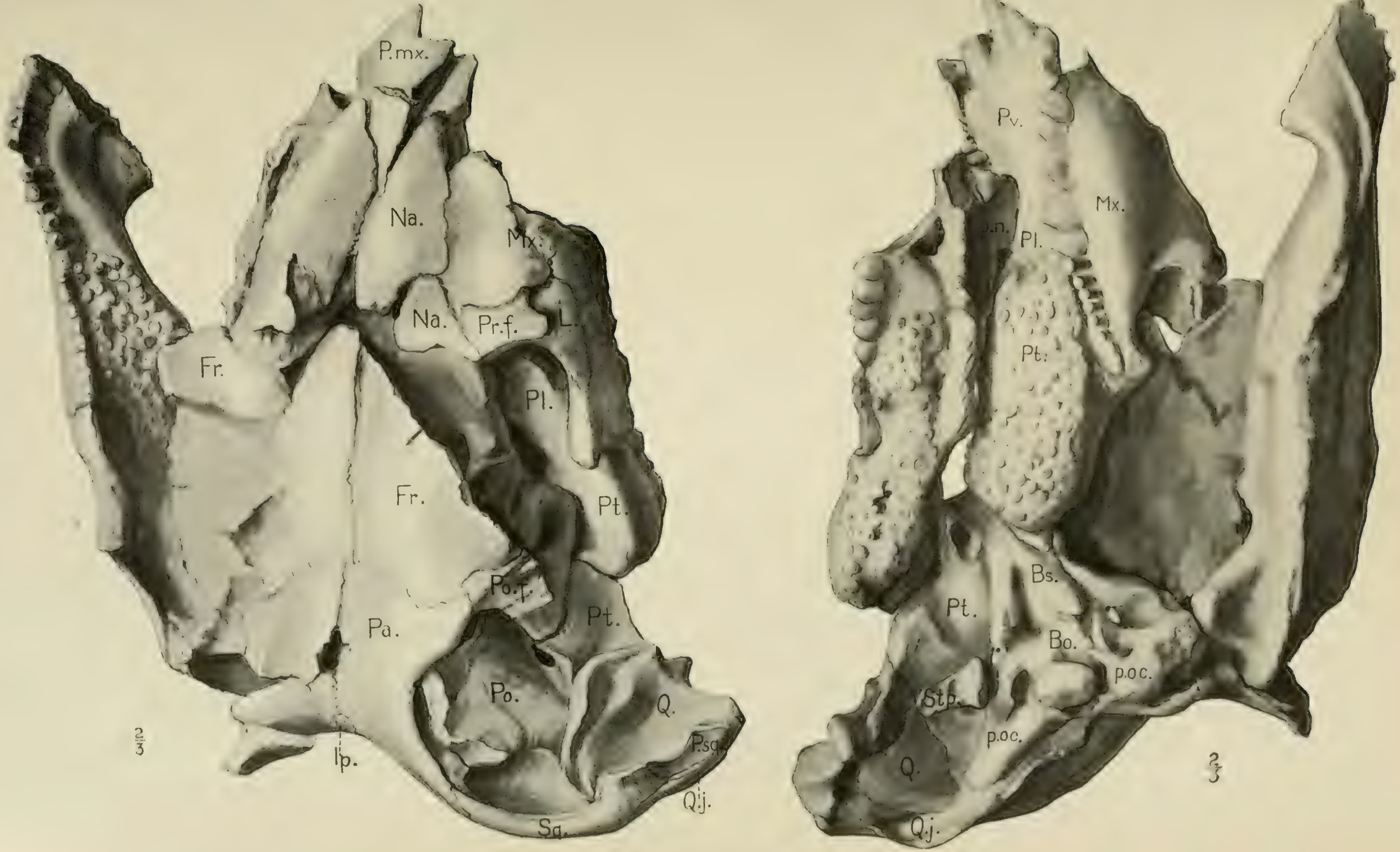
EXPLANATION OF PLATE VII.

FIG. 1. — Upper surface of the skull of *Edaphosaurus pogonias* Cope. No. 4009 Am. Mus., x $\frac{2}{3}$. *pmx.* premaxillary, *n.* nasal, *mx.* maxillary, *pf.* prefrontal, *l.* lachrymal, *pl.* palatine, *pt.* pterygoid, *f.* frontal, *po.* paroccipital, *p.* parietal, *ptf.* postfrontal, *q.* quadrate, *qj.* quadratojugal, *sq.* squamosal, *psq.* prosquamosal.

FIG. 2. — Lower view of the same. Lettering as in figure 1 and; *pv.* prevomer, *pn.* posterior nares, *bs.* basisphenoid, *bo.* basioccipital, *st.* stapes.

---

[1] Pelycosaurier in deutschen Muschelkalk. Neuen. Jahrb. f. Min., Geol., u Paleont., Beilage Bd. XX, 1905, p. 336.


P.mx.
Na.
Mx.
Na.
Pr.f.
L.
Fr.
Pl.
Fr.
Pt.
Po.f.
Pt.
Pa.
Po.
Q.
P.sq.
Ip.
Q.j.
Sq.
2/3
P.v.
Mx.
p.n.
Pl.
Pt.
Bs.
Pt.
Bo.
p.oc.
Stp.
p.oc.
Q.
Q.j.
2/3

EDAPHOSAURUS POGONIAS *Cope.*

56.81, 3 (7)

Article III.— DESCRIPTIONS OF TWO NEW GENERA (*ECHMATEMYS* AND *XENOCHELYS*) AND TWO NEW SPECIES (*XENOCHELYS FORMOSA* AND *TERRAPENE PUTNAMI*) OF FOSSIL TURTLES.

By Oliver P. Hay.

The following results of the author's recent studies of the fossil turtles of North America appear to be worthy of immediate publication.

Echmatemys, gen. nov.

A genus of Emydidæ. Neural plates mostly hexagonal, with the broad end forward. Plastron closely articulated with both the peripherals and the costals; with the latter by means of strongly developed axillary and inguinal buttresses. The axillary buttresses ascending beyond the lower borders of the first costal plates. The inguinal buttresses ascending beyond the peripherals and articulating with the inner surfaces of the fifth and sixth costals at their junction. Skull not certainly known, but apparently having the maxillary triturating surfaces furnished with only a rudimentary ridge. Lower jaw with a narrow triturating surface.

The type of the genus is *Emys septaria* Cope, of the Bridger Eocene.

The Emydidæ of the Bridger beds have hitherto been referred to the genus *Emys*. A very superficial examination of the carapace shows that these turtles cannot be congeneric with *Emys orbicularis*, the type of *Emys*. In the latter the plastron is joined to the carapace by means of ligaments, and there is a hinge between the hyoplastra and the hypoplastra. In most of the Bridger turtles the plastron is firmly joined to the carapace and there is no hinge. Besides the usual sutural union of the upper and lower portions of the shell, strong anterior and posterior buttresses ascend from the floor of the plastron and join suturally the inner surfaces of some of the costals. Usually these buttresses, especially the posterior ones, are broad, the inner border of the base rising from the plastron half way between the outer border of the posterior lobe and the midline of the plastron. In the American Museum of Natural History there is a specimen of Cope's *Emys septaria* from which is removed the hinder portion of the carapace in such a way as to expose in position the inguinal buttresses. Figure 1 represents a view of these buttresses and the surrounding parts as seen from behind. The width of the carapace is 225 mm. while the width of the space left between the buttresses is only about 80 mm. While the space left between the anterior buttresses is greater, the latter extend well inward. The effect of these broad partitions is to cut off on each side of the body a deep sternal chamber. In some of the species the buttresses are not so broad. The height to which they rise varies, but it is always greater than the lower borders of the costals concerned. The hinder buttresses ascend sometimes to a point two-thirds the distance from the lower to the upper border of the fifth and sixth costals.

We have little certain knowledge of the structure of the skull. Nevertheless, there is in Princeton University the skull of a Bridger emyd which in all probability belongs to some member of the new genus here proposed. The triturating surface of the upper jaw is narrow and there is at its hinder end a low and short ridge, the homologue of that which is so conspicuous in numerous modern genera of emyds. In the American Museum there is a portion of a lower jaw which accompanies considerable parts of the shell of a member of the genus. The triturating surface is narrow and furnished with a longitudinal groove. The jaw has evidently resembled that of the Chinese genus *Ocadia*, a figure of which is found in 'Boulenger's Catalogue of Chelonians,' page 86.

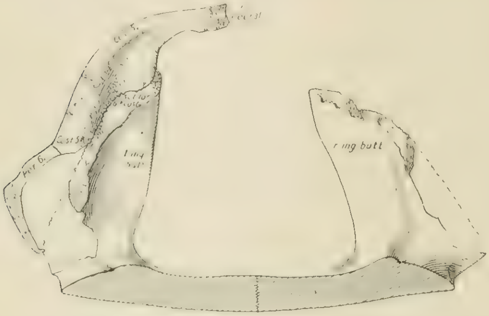


Fig. 1.—*Echmatemys septaria*. Inguinal buttresses from behind. x $\frac{1}{3}$.

The genus *Ocadia* resembles in many respects the one here proposed. It has strongly developed anterior and posterior buttresses; and the general structure of the skull is that of the Bridger skull referred to above. However, the triturating surface of the Asiatic genus is furnished with a well developed longitudinal ridge. The evidence and the probabilities are that no such ridge was present in the species of the Lower Eocene. Likewise the hinder lobe of the plastron of *Ocadia* is narrower than that of the Bridger species.

Besides *Ocadia* there are in Asia four genera which have the buttresses still more powerfully developed. These are *Kachuga*, *Callagur*, *Batagur*, and *Hardella*. All of these have one or more longitudinal ridges on each maxillary triturating surface.

To the genus *Echmatemys* will be referred, besides *Emys septaria*

Cope, also *Emys cibollensis* Cope and *Emys lativertebralis* Cope, both of the Wasatch beds of New Mexico.

Xenochelys, gen. nov.

A genus of Dermatemydidæ. Neurals six, the anterior four having the narrow end in front. Costals seven pairs, those of the sixth and seventh pairs meeting in the midline above. Plastron joining the carapace without intervention of buttresses. Only five pairs of plastral epidermal scutes. Two inframarginals on each bridge. Type, *X. formosa*, of the Oligocene.

Xenochelys formosa, sp. nov.

This species is based on a nearly complete shell which was discovered in 1904, at Quinn Draw, Washington County, South Dakota, by Mr. Albert Thomson, of the American Museum of Natural History. The deposits from which it was taken belong to the lower Titanotherium beds, of the White River formation.

The length of the carapace (Figure 2) is 200 mm., the width, 129 mm. There is a low median carina on the nuchal and again on the hinder end of the carapace. There are traces of a lateral carina on each side. The plastron (Figure 3) is 163 mm. long. The anterior lobe is 80 mm. wide at the base. The bridge is 43 mm. wide. The

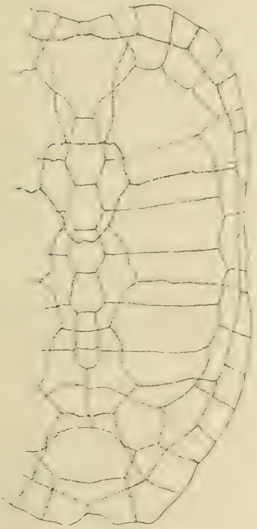


Fig. 2.—*Xenochelys formosa.* x. $\frac{1}{3}$. Diagram showing outlines of bones and horny scales of carapace.

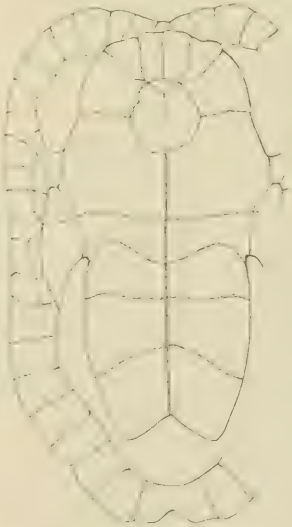


Fig. 3.—*Xenochelys formosa.* x $\frac{1}{3}$. Diagram showing outlines of bones and horny scales of plastron.

posterior lobe is 75 mm. long and 62 mm. wide at the base. There are only five pairs of epidermal scutes on the plastron, the pectorals and the abdominals either having apparently fused or one or the other been suppressed.

The discovery of this genus of Dermatemydidæ in the Oligocene of this country is very interesting. The few surviving members of the family are confined to Central America. Forms which are to be referred to this family were common in the Upper Cretaceous of New Jersey and have been described under the genera *Adocus*, *Agomphus*, and *Zygoramma.* A still older genus is *Basilemys* of the Judith River and Belly River beds. This genus extends also into the Laramie formation. In the Puerco beds is found the genus *Hoplochelys*, based on Cope's *Chelydra crassa.* The next appearance of the family is in Bridger deposits of Wyoming where *Baptemys wyomingensis* Leidy is not uncommon.

Terrapene putnami, sp. nov.

Some time ago Prof. F. W. Putnam, at that time of the American Museum of Natural History, placed in the writer's hands for examination some bones which had been dredged from the Alifia River, Florida, about a mile from its mouth. This river empties into Tampa Bay. Among these bones are fragments of *Trachemys euglypha* (Leidy), the type of which came from the Peace Creek beds, believed to belong to the Pliocene, but which appear to furnish some living species. Most interesting of the materials presented by Prof. Putnam is the left hypoplastral of a new species of *Terrapene*, which, in honor of the donor, is called *Terrapene putnami.*

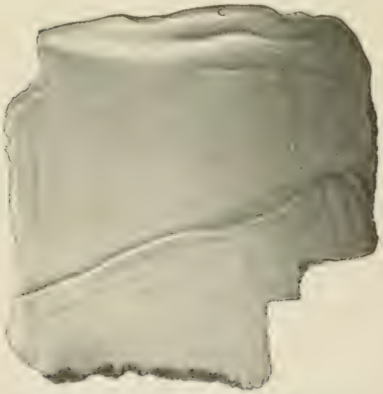


Fig. 4.—*Terrapene putnami.* x $\frac{2}{3}$. Wash-drawing of the lower surface of the left hypoplastron.

This new species is remarkable for its size and for the thickness of the shell. The bone to be described (Figure 4) is nearly square, its length and breadth each being 73 mm. If this bone had the same ratio to the rest of the shell that the corresponding bone of *T. carolina* has, the carapace had a length of 265 mm., or ten and a half inches. The width of the carapace was about 200 mm. At the midline, just in front of the articulation of the bone with the xiphiplastron, the hypoplastron is 22.5 mm. thick. In a specimen of *T. carolina* whose hypoplastron is 38 mm. wide the thickness at the point named is only 4 mm. In the fossil the width becomes reduced laterally to 12 mm. two-fifths the distance toward the hinge. It then increases and

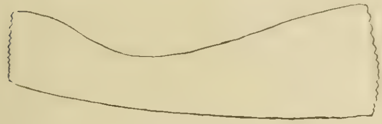


Fig. 5.—*Terrapene putnami.* x $\frac{2}{3}$. Section from midline to hinge.

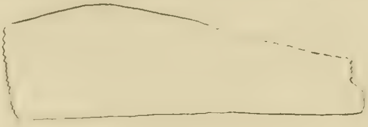


Fig. 6.—*Terrapene putnami.* x $\frac{2}{3}$. Outline of the mesial face of the hypoplastron.

at the hinge is 15 mm. Figure 5 is a section across the bone from the midline to the hinge, while Figure 6 shows the thickness of the border which joins the bone of the opposite side, the narrow end of the figure representing the anterior hinge.

Figure 7 represents the lateral hinge, the hinder end of which is broken away. At its anterior end is a deep and rough pit to receive a process from the carapace, such as we find in *T. carolina*. Behind this is a broad, rough, and perpendicular surface, which joined a similar surface of the carapace. This hinge resembles more that of *T. ornata* than that of *T. carolina*. *T. marnochii*, a large species, was described by Prof. Cope from the Equus beds of Texas, but it appears to have had no such broad hinge.

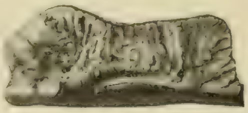


Fig. 7.—*Terrapene putnami.* x $\frac{2}{3}$. View of the lateral hinge.

The hyo-hypoplastral hinge of *T. putnami* differs in no important way from that of *T. carolina*, except in thickness. In the latter species it is about 3 mm. thick; in *T. putnami*, 12 mm. The upper half is rough for the attachment of ligaments; the lower half is smooth and was covered with horny epidermis. On the lower side of the bone is seen the abdomino-femoral sulcus, which, starting from the lateral hinge, runs inward and somewhat backward to the midline.

This paper is published with the consent of the Carnegie Institution of Washington.

59.57, 96 : 15.5

Article IV. — ON THE FOUNDING OF COLONIES BY QUEEN ANTS, WITH SPECIAL REFERENCE TO THE PARASITIC AND SLAVE-MAKING SPECIES.

By William Morton Wheeler.

Plates VIII–XIV.

Introduction.

The following paper is a continuation of work previously published on our North American symbiotic ants. It comprises a series of observations and experiments made during the past summer while I was on a month's vacation in the Litchfield Hills of Connecticut, a locality abounding in interesting Formicidæ. Somewhat later in the season the work was continued at my home in Bronxville, New York. I had planned to devote all my time to ascertaining the method of colony formation adopted by young queens of our common slave-making ants (*Formica sanguinea* subspecies and varieties), but the opportunity to renew my study of *Formica consocians*, the discovery of another interesting and probably parasitic species (*F. nepticula*) with diminutive females, and the opportunity of performing some experiments on still other species of the *F. rufa* group, induced me to enlarge the scope of my work. As the habits of all these species have been hitherto very imperfectly known, I have included some illustrations of their nest architecture.

While the exclusive and intensive study of the structure and ethology of a single type is unquestionably of great value if only as a guide to what we may expect to find in allied but as yet unstudied forms, this method is, nevertheless, sometimes misleading and illusive, for the very reason that it may lead us to prejudge a field of inquiry. It would be difficult to find a better illustration of the truth of this statement than the study of the honey-bee. The remarkable conclusions reached from the long and painstaking investigation of this economic insect, have been again and again extended, either unconsciously or intentionally, to the other groups of social insects. And it is especially the instincts of the queen bee that have been thus adopted as a paradigm of the female instincts in other Hymenoptera such as the ants. A moment's reflection, however, shows the error involved in any such generalization even when extended to insects as closely related to the honey-bee as the humble-bees and the wasps.

[*May, 1906.*]

The queen bee is a degenerate organism—a perambulating ovary, incapable of founding a colony unaided, shorn of the primitive pollen-collecting apparatus and instincts of the ancestral wild bees, no longer capable of visiting the flowers and of feeding either herself or her offspring. The worker bee, on the other hand, apart from her normal infertility, is more like the ancestral female bee in still retaining all the attributes of that sexual form. While the queen bee has thus, as it were, delegated to her workers all the female functions and structures except those of normal reproduction, the great majority of female ants, as the following paper will abundantly show, have lost very few or none of the primitive female instincts of the species. In fact, the instincts of the ant-species have their center of gravity, so to speak, in the female and not, as is usually supposed, in the worker. That nearly all writers on these insects should be more or less biased by the study of the honey-bee, is due to the fact that the female ant is apt to be stolid and very slow to respond to the stimuli of her environment, while the instincts of the workers are persistently and conspicuously manifested. Yet the fertilized and isolated female ant is self-sufficient in structure and instincts, since she is able to reproduce the whole colony—males, females, and workers—from her own substance. She is not only the winged germ of the species, but the epitome of its instincts, and, unlike the females of most Hymenoptera, she undoubtedly adds to her inherited capacities the results of individual experience and imitation gained during her prenuptial sojourn in the maternal nest.

Female, or queen, ants in founding their colonies resort to one of three methods, which may be known as the usual or typical, the redundant, and the defective. In the first method there is a manifestation of instincts of the ordinary and undoubtedly primitive type, as displayed by nearly all the species of Formicidæ; in the second there are adventitious instincts leading to a more complicated activity, and in the third method there is a lapsing of original instincts and a substitution of others. More explicitly, these different methods may be described, as follows:

1. The female ant is able by herself alone to start her colony; that is, under favorable circumstances she can produce and bring to maturity the first brood of workers and thus insure the further growth and development of the colony. She is capable of passing many months without nourishment even while she is feeding her offspring. Her voluminous fat-body, built up during her larval life in the maternal nest, together with her degenerating wing-muscles, furnish the sub-

stances that are converted into food for the young. Although so arduous that few of the many queens of all that celebrate their nuptial flight during a season ever succeed in establishing a colony, this method is, nevertheless, the one adopted by the great majority of ants.

2. The female is not only able to accomplish all that is implied in the usual method of founding a colony, but in addition she can carry over to her colony and cultivate certain plants that have been grown as food for countless generations by the stock from which she sprang. This is the case in the remarkable fungus-raising ants (*Attii*) of tropical and subtropical America.

3. The female ant, owing to her small and delicate stature or delayed fertility, is quite unable to found a colony without the aid of workers of another species. This method which is resorted to by parasitic species—using that term in a very broad sense—appears under three different aspects:

A. As *temporary social parasitism.* The female seeks and obtains adoption in a small queenless colony of another species and permits its alien workers to bring up her young. When these have matured, they emancipate themselves and become an independent colony, either by emigration or, more probably, only through the natural death of the host species.

B. As *permanent social parasitism.* The female seeks and obtains adoption in a colony of some other species and there permanently resides together with her offspring. Examples: *Anergates*, *Strongylognathus*, *Protomognathus*, *Wheeleria*, etc.

C. As *dulosis, or slavery.* The solitary female enters a small colony of another species, kills the workers, and seizes and rears the progeny (larvæ and pupæ) as a first step towards bringing up her own young. The workers produced by the female subsequently make forays on other colonies of the host species and appropriate their offspring. While they use a portion of these as food, they permit another portion to develop as "auxiliaries" or "slaves," so that the colony preserves its "mixed" character. This method is adopted by some, if not by all, the forms of the sanguinary ant, or blood-red slave-maker (*Formica sanguinea*). The amazon ants (*Polyergus*) appear to combine this with the preceding method.

Although in this paper we are especially concerned with temporary social parasitism and dulosis, it may not be amiss to discuss a few matters, mainly of a historical nature, concerning the usual and redundant methods of colony formation.

Pierre Huber was the first to call attention to the method of colony formation adopted by the great majority of female ants. In his remarkable book[1] published nearly a century ago, he writes (pp111–113):

"As soon as they [the female ants] have dropped their wings, they are seen running about over the ground in search of a lair. It would be difficult indeed to follow them through their devious courses and detours in the midst of fields and lawns. Although I have failed to see them establish themselves, I have nevertheless convinced myself, after some trials, that these females, which were required to do no labor in the parental formicaries, and seemed incapable of initiative, become, nevertheless, when inspired by maternal affection and the need of employing all their faculties, industrious and care for their young quite as well as do the workers. I confined several fertilized females in a box full of light, damp earth. They knew how to dig galleries, which they inhabited either singly or in common; they laid and cared for their eggs, and notwithstanding the inconvenience of being unable to regulate the temperature of their dwelling, they reared some of the eggs, which became larvæ of considerable size but perished through my negligence.

"Hereupon I assembled some other females in a similar apparatus and gave them some worker pupæ for the purpose of ascertaining whether their instinct would lead them to open the cocoons; and although these females were virgins and still bore wings, they worked to such good purpose that on the following morning I found three workers in their midst. A few days later I surprised them in the act of liberating other workers from their final envelope; in this they behaved like workers and seemed not to be embarrassed by the occupation in which they were engaged for the first time.

"It is evident, therefore, that the females are able, when necessary, to rear a family quite by themselves. If I endeavored to convince myself of this fact by still more positive proofs, it was less for the purpose of dispelling all my doubts on this matter, than to satisfy my curiosity concerning the composition of these incipient formicaries. After long search I succeeded in discovering the hiding place of these females and the nascent colonies which they had established. These were situated at a slight depth in the soil. There were a few workers with their mother and some larvæ which they were feeding. I have seen two examples of such recently established formicaries. Then, too, one of my friends [M. Perrot of Neufchatel, an excellent naturalist] whose observations are worthy of implicit confidence, one day discovered, in a small subterranean cavity, a female ant living alone with four pupæ, for which she appeared to be caring."

---

[1] Recherches sur les Mœurs des Fourmis Indigènes. Paris and Geneva, 1810.

While we must still admire, in the light of our present knowledge, the accuracy of Pierre Huber's statements, we must not forget that he largely inferred the method of colony formation and did not actually observe the female ant bringing her firstling brood of workers to maturity. Subsequent authors have not failed to notice this important hiatus in the work of that gifted naturalist. As late as 1874 we find Forel (pp. 417–419)[1] still balancing the views of St. Fargeau, Ebrard, and Lepeletier with those of Huber and reaching the conclusion, which was really no conclusion at all, that "There is left to us only Lepeletier's supposition, but I believe that we must refrain from accepting it as an established fact. Nor am I of the opinion that we are justified in absolutely discarding Huber's conception."

Although Mayr[2] in 1864 observed isolated female ants with eggs, the actual founding of a colony by a single queen was first witnessed by an American of somewhat doubtful reputation as a myrmecologist, Dr. Gideon Lincecum.[3] His work seems to have been overlooked by those who have considered this subject. In 1866 he wrote as follows of the Texas agricultural ant (*Pogonomyrmex barbatus* var. *molefaciens*):

"When one of the young queens, or mother ants, comes to maturity, and has received the embraces of the male ant, who immediately dies, she goes out alone, selects a location, and goes rapidly to work excavating a hole in the ground and carrying out the dirt with her mouth. As soon as she has progressed far enough for her wings to strike against the sides of the hole, she deliberately cuts them off. She now, without further obstruction, continues to deepen the hole to a depth of 6 or 7 inches, when she widens the bottom of it into a suitable cell for depositing her eggs and nurturing the young. She continues to labor outdoors and in, until she has raised to maturity 20 to 30 workers, when her labor ceases, and she remains in the cells, supplying the eggs for coming millions, and her kingdom has commenced. But very few of the thousands of mother ants that swarm out from the different kingdoms two or three times a year succeed in establishing a city. However, when one does succeed in rearing a sufficient number of workers to carry on the business, she entrusts the management of the national works to them and is seen no more outside. . . .

"The workers increase the concealment which has been kept up by the mother ant during the period of her personal labors, of the passage, or gateway to their city, by dragging up and covering it with bits of stick, straw, and the hard black pellets of earth, which are thrown up by the earthworms, until there is no way visible for them to enter; and the little litter is so ingeniously placed, that it has more the appearance of having been drifted together by the wind than to have been the work of design.

---

[1] Les Fourmis de la Suisse. Zürich, 1874.
[2] Das Leben und Wirken unserer einheimischen Ameisen. Wien, 1864.
[3] Proc. Phil. Acad. Nat. Sci., 1866, pp. 323, 324

"In about a year and a half, when the numbers of the community have greatly increased, and they feel able to sustain themselves among the surrounding nations, they throw off their concealment, clear away the grass, herbage, and other litter to the distance of 3 or 4 feet around the entrance of their city, organize an efficient police, and, thus established, proclaim themselves an independent city," etc.

Essentially the same account was published by Lincecum in 1874 in another article[1] and is repeated in McCook's larger work on the Texan agricultural ant (pp. 146 *et seq.*).[2]

My own observations on this same ant confirm Lincecum's in every important detail, except that I have never seen the female return to the surface after she had excavated her burrow. She closes it behind her and, thus shut off from the world, devotes herself to bringing up her brood, like the females of most ants. I am glad to record my nearly complete agreement with Lincecum in this matter because I am unable to accept his account of some of the other instincts of *Pogonomyrmex*.[3]

The first to witness the founding of a colony in an artificial nest, that is, under conditions accurately controlled, was Sir John Lubbock. His account, originally published in 1879,[4] is reproduced in the various editions of his well-known book on ants, bees, and wasps. On Aug. 14, 1876, he isolated two pairs of *Myrmica ruginodis* and succeeded in keeping them in a perfectly healthy condition through the winter. The males died during the following April and May. The females laid during the latter part of April. Some of the young had pupated by the first of July and the firstling workers appeared and began to care for the remainder of the brood by the end of that month and the first week in August. This demonstrated, as Lubbock said, "that the queens of *Myrmica ruginodis* have the instinct of bringing up larvæ and the power of founding communities."

In 1883 McCook[5] published a number of careful observations by

---

[1] The Agricultural Ant. Am. Nat., Vol. VII, 1874, No 9, pp. 514, 515.

[2] The Natural History of the Agricultural Ant from Texas. Philadelphia, 1879.

[3] See my paper: A New Agricultural Ant from Texas, with Remarks on the Known North American Species. Am. Nat., Vol. XXXVI, Feb., 1902, pp. 91 et seq.

[4] Observations on Ants, Bees, and Wasps. Part V, Ants. Journ. Linn. Soc., Vol. XIV, 1879 pp. 265–290.

[5] How a Carpenter Ant Founds a Colony. Proc. Phila. Acad. Nat. Sci., Vol. XXIV, 1883, p. 303.

Edward Potts to show that young females of *Camponotus pennsylvanicus* "when fertilized, go solitary, and after dispossessing themselves of their wings, begin the work of founding a new family. This work they carry on until enough workers are reared to attend to the active duties of the formicary, as tending and feeding the young, enlarging the domicile, etc. After that, the queens generally limit their duty to the laying of eggs," etc.

To any one who has given even a little attention to the insect life of our northern woods, it seems strange that the founding of colonies by this ant should not have been recorded till 1883. Certainly no observation could be more easily made, for in many localities it is hardly possible to tear a strip of bark from an old log without finding one or more females of *C. pennsylvanicus* or of the allied varieties *ferrugineus* and *novæboracensis*, each in her little cell brooding over a few eggs, larvæ, cocoons, or minim workers. Usually the cell is carefully excavated just under the loose bark in the decayed wood, but where pine logs are abundant these females often prefer to take possession of the deserted pupal cavities of a longicorn beetle (*Rhagium lineatum* Oliv.). These cavities are surrounded by a regular wall of wood fibers arranged like the twigs in a bird's nest (Pl. VIII, Fig. 1).

Within more recent years the observations of Lincecum, Lubbock, McCook, and Potts have been repeatedly confirmed by continental authors. Blochmann,[1] Forel,[2] Janet,[3] von Buttel-Reepen,[4] and Emery[5] have all published interesting notes on colony formation by isolated females of ants belonging to the common genera *Myrmica*, *Cremastogaster*, *Formica*, *Lasius*, and *Camponotus*.

On more than one occasion during the past six years I have myself been able, both in the field and in the laboratory, to test the truth of these observations. In fact, a catalogue of the North American species, in which I have seen evidence of the founding of colonies by isolated females, would comprise nearly all of our common ants. I have observed it in members of all the subfamilies except the Dorylinæ. Even the Ponerinæ, which I at one time supposed to be an exception, conform to the general rule, for I have found isolated female of *Odontomachus clarus* and *hæmatodes* in the act of establishing their formicaries. During the past May (1905) I observed an unusually striking case of colony formation by queens of the Californian harvester (*Pogonomyrmex californicus*) on the edge of the Mojave Desert. This observation recalls the above quoted passage from Lincecum on the Texan harvester. I arrived at Needles, California, May 23, a day or two after the nuptial flight of *P. californicus*. This was proved by the thousands of isolated females of this species, in the act of establishing their formicaries. The country in which I observed them was the sandy bottom on the right bank of the Colorado River and the adjacent low escarpment of the desert. The latter is interrupted by numerous short 'draws,' which are more or less sandy like the river bottom into which they open. The surface of the escarpment, however, is very hard and stony, but it, too, is furrowed by very small 'draws' often only a few inches wide and containing sand washed from the surrounding surfaces by the winter showers. After their nuptial flight myriads of *Pogonomyrmex* females had rained down over the whole hot, dry country for a distance of at least three miles to the south and as many to the west of the Needles. After losing her wings, each female sought out the regions of pure sand, avoiding the hard surfaces, and set to work digging a hole. The earth was brought out to one side of the burrow so as to form a diminutive fan-shaped mound, which when completed was about two inches in diameter (Pl. VIII, Fig. 2). On May 23, during the hot morning hours the females could be seen at work everywhere in the 'draws' and river bottom, often within a few inches of one another. Many had already completed their burrows, which extended down obliquely to a depth of three or four inches, and had closed the opening behind them. It was an easy matter to dig a deälated female from each spot indicated by a small fan-shaped mound or to tempt her to the surface by inserting a straw into her burrow. A wind- or rainstorm would have obliterated at once all traces of the whereabouts of these females. That they actually sought the pure sand, which is also the substance in which the adult colonies are found, was seen on the top of the escarpment. There each tiny draw was literally filled with incipient nests, although none could be found on the hard intervening spaces often hundreds of feet wide. The ants would, in fact, be quite unable to excavate in such hard soil. The comparatively small number of adult colonies in the vicinity proved that but few of these isolated females ever succeed in rearing a colony. They are doomed to rigid, all but catastrophic, elimination, which only the best endowed and most favorably situated can survive.

---

[1] Ueber die Gründung neuer Nester bei Camponotus ligniperdus Latr. und anderen einheimischen Ameisen. Zeitschr. f. wiss. Zool., Bd. XLI, 1885, pp. 719–727.

[2] Origine d'une Fourmilère de Camponotus ligniperdus Latr. Ann. Soc. Ent. Belg., XLVI, 1902, pp. 180–182, and Suite de l'Histoire de mon Camponotus ligniperduso. *Ibid.*, XLVI, 1902, pp. 294–296.

[3] Observation sur les Fourmis. Limoges, 1904, 68 pp. 7 pl.; and Études sur les Fourmis, Troisième Note. Bull. Soc. Zool. France, Vol. XVIII, 1803, pp. 168–171.

[4] Sociologisches und Biologisches vom Ameisen- und Bienenstaat. Wie entsteht eine Ameisen kolonie? Arch. f. Rassen u. Gesell. Biol., 2 Jahrg., 1. Heft, Jan. u. Feb., 1905.

[5] Sur l'origine des fourmilières. Compt. Rend. 6me Congrès intern. de Zoologie, Session de Berne, 1904, May 25, 1905, pp. 459–461.

In the foregoing paragraphs attention has been repeatedly called to the fact that an ant colony is started by a single isolated female. This requires some qualification, since under very exceptional circumstances a couple of females from the same maternal nest may meet after their marriage flight and together start a colony. During August, 1904, I found two deälated females of *Lasius brevicornis* occupying a small cavity under a clump of moss on a large boulder near Colebrook, Connecticut. They had a few larvæ and small cocoons and a couple of tiny callow workers. The colony was transferred to an artificial nest and kept for several days. Both females were seen to take part in feeding and caring for the single packet of larvæ and freeing the remaining callows from their cocoons. Without doubt these twin females were sisters that had accidentally met under the same bit of moss and had renewed the friendly relations in which they had lived before taking their nuptial flight. This case is of considerable interest because, as a rule, even sister ants seem averse to such postnuptial partnerships. This is indicated by some of the observations on *Formica consocians* recorded in the sequel.

We wonder at the extraordinary endurance which enables the female of our common ants to live so many months without food while she is metabolizing her fat-body and functionless wing-muscles into eggs and the salivary secretion with which to feed her first brood of workers, but the huge female of the American species of *Atta* (in the restricted sense) not only accomplishes this difficult and complicated task, but simultaneously cultivates a fungus garden as a means of providing herself and progeny with food. The founding of colonies by the females of the larger Brazilian leaf-cutting ants has been studied by Sampaio de Azevedo,[1] von Ihering,[2] Goeldi,[3] and Jakob Huber.[4]

Sampaio, on digging up an *Atta* female ten days after the nuptial flight, found her in a cavity with two small white masses, one consisting of 50–60 eggs, the other of a filamentous substance which was the young fungus garden though not recognized as such. Three and one half months after the nuptial flight he excavated another nest which had an opening to the surface of the soil. He found numerous workers of three different sizes but all smaller than the corresponding castes in adult colonies. They were already cutting leaves and had a fungus garden about 30 cubic centimeters in volume. He estimated the number of workers at 150 to 170, that of the larvæ and pupæ at about 150, and the eggs at 50.

---

[1] Saúva ou Manhúaára. São Paulo, 1894

[2] Die Anlage neuer Kolonien und Pilzgärten bei Atta sexdens. Zool. Anzeig., XXI, pp. 238–245.

[3] Forel. A., Einige Biologische Beobachtungen des Herrn Prof. Dr. Goeldi an brazilianischen Ameisen. Biolog. Centralbl., XXV, März, 1905, pp. 170–181. Goeldi, Beobachtungen über die erste Anlage einer neuen Kolonie von Atta cephalotes. C. R. 6me Congr. internat. Zool. Berne, 1905, pp. 457, 458; also Myrmecologische Mittheilung das Wachsen des Pilzgartens bei Atta cephalotes betreffend, *ibid.*, pp. 508, 509.

[4] Ueber die Koloniengründung bei Aatta sexdens. Biolog. Centralbl., XXV, 1905, pp. 606–619, 625–635, 26 figs.

The much more important observations of von Ihering, including his brilliant discovery of the method of transfer of the fungus culture from the maternal to the daughter colony, deserve fuller consideration. According to this observer there are repeated nuptial flights of the Brazilian *Atta sexdens* from the end of October to the middle of December. His account of these flights shows that they are essentially like those of other ants, so that his supposition that the female may be fertilized in the parental nest is without foundation. His account of the founding of the colony is so interesting that I cannot refrain from quoting it.

The fertilized female "rids herself of her easily detached wings by quick motions of her legs and then begins to dig her burrow in some spot more or less free from vegetation. This canal is nearly or quite vertical and measures about 12–15 mm. in diameter. It is so narrow that the 'Iça' cannot turn round in it, but is compelled to walk backwards whenever she returns to the surface. She bites off lumps of earth with her powerful jaws, makes them into a pellet by means of loose threads of saliva, brings them up and deposits them a short distance from the entrance to the burrow. The earth thus brought up forms a circular wall, thickened in front and interrupted behind, about 4–5 cm. broad in front and at that point 3 cm. from the entrance. The burrow varies in length according to circumstances from 20–30 cm. and ends in a small laterally placed chamber about 6 cm. long and somewhat less in height. As soon as the chamber is completed, the ant closes the upper portion of the burrow to a distance of 8–10 cm. from the entrance with pellets of earth and this closure becomes more and more compact in the course of weeks, probably through the action of the rain.

"If the nest be opened in one or two days, the female will be found in the empty chamber unchanged, only more lethargic, as if exhausted. A few days later one finds near the ant a little packet of 20–30 eggs undergoing segmentation. Beside them lies a flat heap of loose white substance, only 1–2 mm. in diameter. This is the earliest rudiment of the fungus garden. Microscopical examination shows that it consists of compact masses of the well-known fungus-hyphæ, but no traces of "kohlrabi" corpuscles. As time goes on the fungus garden grows rapidly and becomes more voluminous till it reaches a diameter of about 2 cm. It seems to consist of closely aggregated spherules about 1 mm. in diameter. As soon as it has attained this size the trans-parent pyriform globules bud out, which Moeller called "kohlrabi" and the ant is seen to eat them frequently. She always keeps close to the fungus garden and in it embeds her eggs. The larger of these soon become larvæ. The eggs are not spun over with fungus hyphæ but have the chorion smooth and shining. Eggs are also found in the interior of the fungus mass, which the ant keeps rearranging and redistributing from time to time. It was easy, for purposes of observation, to transfer the ant to a terrarium. Without excavating anew she remained with her garden on the fresh layer of earth. The garden did not grow, but rather diminished in volume, for it is difficult to imitate the conditions, especially the precise degree of moisture, in which it grows and develops in its cavity. I failed, therefore, to keep the ant and her garden till the first workers appeared.

"The time required to accomplish this must be between two and three months. Presumably the last phase of this first brood period is very precarious, since leaves must be brought in to serve as a substratum for the further growth of the fungus garden. In any event, the development of the garden is in need of further elucidation. According to my investigations, which need fuller confirmation, the organic substratum is provided in the form of malaxated eggs, but perhaps the soil, which is rich in vegetable mould, may itself contain nutrient substances. . . .

"As soon as the first workers appear, the colony may be regarded as established and the opening up of the burrow, the enlarging of the first chamber, carrying in of leaves, etc., lead to the well-known conditions of the adult colony. . . .

"The preceding description is hardly complete without an answer to the question: Whence come the fungus germs for the establishment of the new garden?" After searching the queen for fungus spores concealed about her person, von Ihering made the important discovery that "every *Atta* queen, on leaving the parental nest, carries in the posterior portion of her oral chamber a loose pellet, .6 mm. in diameter, consisting of hyphæ of *Rhozites gongylophora*, small fragments of bleached, *i. e.*, chlorophylless leaves, and chitinous bristles. The last are undoubtedly derived from the larvæ undergoing ecdysis in the parental nest." Von Ihering is of the opinion that the female keeps the pellet of hyphæ, etc., in her mouth till she has excavated her chamber and then spits it out where it will serve to kindle the fungus garden of the new colony.

The observations of Goeldi are little more than a confirmation of those of von Ihering. He maintains that the fungus is actually grown on some of the malaxated eggs of the *Atta* queen, who would thus be sacrificing a part of her offspring as a culture medium for the fungus that i to nourish both herself and her workers in their larval and adult stages.

None of these investigators succeeded in rearing an *Atta* colony from its very inception till the hatching of the firstling workers and the bringing in of the leaves for the purpose of keeping up the fungus culture. This has been accomplished very recently by Jakob Huber, who, besides correcting a few errors in the work of his predecessors, has added a number of new and important observations. His paper, from which the following abstract is taken, also contains several interesting figures from photographs of the *Atta* female, her progeny, and fungus garden.

The female expels the pellet from her buccal pocket the day following the nuptial flight. It is a little mass .5 mm. in diameter, white, yellowish, or even black in color, and consists of fungus hyphæ imbedded in the substances collected from the ant's body by means of the strigils on her fore feet and thence deposited in her mouth. By the third day 6 to 10 eggs are laid. At this time also the pellet begins to send out hyphæ in all directions. The female separates the pellet into two masses on this or the following day. For the next 10 to 12 days she lays about 10 eggs daily, while the fungus flocculi grow larger and more numerous. At first the eggs and flocculi are kept separate, but they are soon brought together and at least a part of the eggs are placed on or among the flocculi. Eight or ten days later the flocculi have become so numerous that they form when brought together a round or elliptical disc about 1 cm. in diameter. This disc is converted into a dish-like mass with a central depression in which the eggs and larvæ are henceforth kept. The first larvæ appear about 14 to 16 days after the *Atta* female has completed her burrow, and the first pupæ appear about a month after the inception of the colony. By this time the fungus garden has a diameter of about 2 cm. There are no "kohlrabi" corpuscles in the earlier stages, and when first seen they are at the periphery of the disc. A week later the pupæ begin to turn brown and in a few days the first workers hatch. Hence the time required for the establishment of a colony under the most favorable conditions is about 40 days. After this rapid survey of the matter, Huber asks the important question: How does the Atta female manage to keep the fungus alive? Obviously the small amount of substance in the original pellet must be soon exhausted and the growing hyphæ must be supplied with nutriment from some other source. His interesting answer to this question may be given in his own words:

"After carefully watching the ant for hours she will be seen suddenly to tear a little piece out of the fungus garden with her mandibles and hold it against the tip of her gaster, which is bent forward for this purpose. At the same time she emits from her vent a clear yellowish or brownish droplet which is at once absorbed by the tuft of hyphæ. Hereupon the tuft is again inserted, amid much feeling about with the antennæ, in the fungus garden, usually not in the same spot from which it was taken, and is then patted in place by means of the fore feet. The fungus then sucks up the drop more or less quickly. Often several of these drops may be clearly seen scattered over the young fungus garden. According to my observations this performance is repeated usually once or twice an hour, and sometimes, to be sure, even more frequently. It can almost always be observed a number of times in succession when a mother ant that has no fungus, as sometimes happens in the cultures, is given a piece of fungus belonging to another *Atta* female or from an older colony. The mother ant is visibly excited while she explores the gift with her antennæ, and usually in a few minutes begins to divide it up and rebuild it. At such times she first applies each piece to her vent in the manner above described and drenches it with a fecal droplet."

From these observations Huber concludes that the droplet must be liquid excrement and that the fungus owes its growth to this method of manuring. A direct use of malaxated eggs for this purpose was never observed and could not be detected by microscopical examination, although a number of observations show that the same result may be accomplished indirectly, namely by the female eating her own eggs. This habit is so common and apparently so normal that Huber estimates that 9 out of every 10 eggs are devoured by the mother, often as soon as they are laid. The life of the *Atta* female in her little cell during all this time is very rhythmical. At regular intervals she conscientiously examines the walls of the cavity, flattens out the earth, etc. She devotes more time to licking and manuring the fungus garden and, of course, lavishes most care on the brood.

As soon as the larvæ appear they are fed directly with eggs thrust into their mouths by their mother. Huber concludes that this is their normal diet till the first workers hatch. He never saw the female either eating the fungus mycelium herself or feeding it to the young. As a proof of his contention he cites the case of one of his *Atta* queens who brought up a brood without a fungus garden. With the appearance of the firstling workers, which are minims, that is members of the smallest worker caste, a change comes over the colony. They begin to usurp the functions of the mother ant. They manure the garden, which at the time of their appearance measures hardly more than 2.5 cm. in diameter, and feed the larvæ with their mother's eggs. The workers themselves, however, feed on the "kohlrabi" which has been developing on the hyphæ for some time. After about a week some of the workers begin to dig in the earth, and ten days after the appearance of the first worker and seven weeks after the inception of the colony, they break through to the surface of the soil and surround the entrance of the nest with a tiny crater of earthen pellets. They now begin to bring in pieces of leaves, knead them up into minute wads, and insert them in the fungus garden. The method of manuring the garden with fecal droplets seems now to be abandoned. The mother *Atta* henceforth pays no attention to the development of the garden or to the brood, but degenerates into a sluggish, egg-laying machine, while the multifarious labors of the colony devolve on the workers. In the meantime the "kohlrabi" has become so abundant that it can be fed to the larvæ.

In concluding his paper Huber makes the important observation that fertile females of *Atta sexdens* are readily adopted by strange workers of their own species. Such adoptions may be frequently resorted to in a state of nature and would perhaps account for the enormous size and great age of some of the formicaries of the larger species of *Atta*, which in this respect resemble the colonies of *Formica rufa* and *F. exsectoides* in the north temperate zone.

In marked contrast with the elaborate habits and great independence of the *Atta* females are those of certain ants which are unable to establish their colonies without the assistance of alien workers. Some of the most remarkable examples of this inability are found in the typical genus *Formica*.

Our American species of *Formica* may be separated into at least five groups, all but one of which may bear the name of a well-known European species. America is, without doubt, the geographical center of the genus and hence an American type for each group would seem to be more appropriate. Nevertheless, both because the European species were first and more thoroughly studied and because they are less variable than their American congeners, they should maintain their position as reference types. The five groups of species are the following:

1. The *fusca* group. European type: *F. fusca* Linn. Typical and most widely distributed American form: *F. fusca* var. *subsericea* Say. Additional varieties: *subænescens* Emery, *argentata* Wheeler, *gnava*

Buckley, *neorufibarbis* Emery, *neoclara* Emery, *montana* Emery. Additional species: *F. subpolita* Mayr with the varieties *neogagates* Emery and *perpilosa* Wheeler; *F. cinerea* Mayr var. *neocinerea* Wheeler; *F. lasioides* Emery and its var. *picea* Emery; *F. rufibarbis* Mayr var. *occidentalis* Wheeler and *F. pilicornis* Emery.

2. The *pallide-fulva* group. Not represented in Europe. Typical and most widely distributed form: *F. pallide-fulva* Latr. subsp. *schaufussi* Mayr, with the varieties: *incerta* Emery, *nitidiventris* Emery, *succinea* Wheeler, *meridionalis* Wheeler and the typical *pallide-fulva.*

3. The *sanguinea* group. European type: *F. sanguinea* Latr. The common American forms are the subspecies *rubicunda* Emery and its var. *subintegra* Emery. Additional subspecies: *puberula* Emery, *obtusopilosa* Emery, *subnuda* Emery. Additional species: *F. pergandei* Emery and *munda* Wheeler.

4. The *rufa* group. European type: *F. rufa* Linn. Additional European forms: *F. pratensis*, *truncicola* and *pressilabris*. The species is represented in America by *F. rufa* subsp. *integra* Nyl. and its var. *hæmorrhoidalis* Emery, subsp. *obscuriventris* Mayr, and its varieties: *integroides* Emery, *rubiginosa* Emery, and *melanotica* Emery and the subsp. *obscuripes* Forel. Additional species: *F. difficilis* Emery and its var. *consocians* Wheeler, *F. oreas* Wheeler, *dryas* Wheeler, and its var. *gymnomma* Wheeler, *ciliata* Mayr, *impexa* Wheeler, *montigena* Wheeler, *nepticula* Wheeler, *nevadensis* Wheeler, *microgyna* Wheeler and its variety *rasilis* Wheeler, *dakotensis* Emery and its variety *wasmanni* Forel.

5. The *exsecta* group. European type: *F. exsecta.* Nyl. American forms: *F. exsectoides* Forel and its var. *opaciventris* Emery. Additional species: *F. ulkei* Emery.

With respect to the method of establishing their colonies these five groups may be arranged under three heads:

1. The ants of the *fusca* and *pallide-fulva* groups agree in having large females that adopt the usual method of colony formation. I have observed this in most of the varieties of both species.

2. Many, if not all, the ants of the *rufa* and *exsecta* groups seem to be temporary social parasites; that is, their young fertilized females are unable to rear a first brood without the assistance of workers belonging to the *fusca* or *pallide-fulva* groups. In several of the species this inability is very clearly indicated by the diminutive stature of the females, which may be actually smaller than the largest workers of their own species and seem to be much less immediately fertile than the females of the *fusca* and *pallide-fulva* groups.

3. The females of some of the species of the *sanguinea* group, such as *F. pergandei* and the different subspecies and varieties of *F. sanguinea*, are dulotic and appear to secure the workers needed for bringing up their first brood by robbing the young of ants belonging to the *fusca* or *pallide-fulva* groups.

Thus the colonies of the ubiquitous, very cowardly, highly adaptable and extremely fertile *F. fusca* and *F. schaufussi* furnish a wide-spread substratum, so to speak, on which at least many of the species of *Formica* belonging to the *rufa*, *exsecta* and *sanguinea* groups have molded their parasitic habits. These species have learned to exploit the *fusca* and *schaufussi* in manifold ways — to use them either merely as nurses for their firstling progeny (temporary social parasitism), or as a permanent food supply and source of auxiliary workers (dulosis). The parasitism thus inaugurated in the genus *Formica* has been developed to its extreme in the allied highly dulotic genus *Polyergus*, the members of which are abjectly dependent on *fusca* or *schaufussi* workers for their food, for the care of their young, and even for the excavation of their nests.

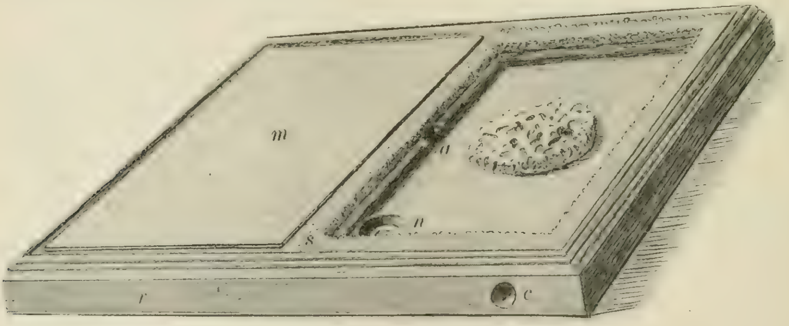


Fig. 1. Artificial ant nest, constructed on the combined principles of the Fielde and Janet nests; with one of the roof-panes removed. *r*, plaster of Paris base, cast in a single piece; *c*, entrance to be plugged with cotton after the admission of the ants from the Forel arena; *m*, glass roof-pane, resting on Turkish towelling (*s*); *a*, opening between the two chambers; *n*, manger; a cup-shaped depression in the plaster base; *e*, slice of sponge, which is kept wet. The plaster base measures 20 × 25 cm.

Inasmuch as the parasitic instincts of these various ants are traceable to the very first foundation of the colony, and since this, as has been abundantly shown in the preceding paragraphs, is the work of the female ant, I have concentrated my experiments on the instincts of this sex, although some miscellaneous notes on nesting habits and other ethological matters which fell under my observation at the same time, have been included in the following pages.

For purposes of study I have used an artificial nest combining the Fielde and Janet patterns (Fig. 1). Of the former I have retained the shape and arrangement of the chambers, the towelling, sponge-slices, roof-panes and the method of roofing the passage-ways between the chambers, but for the glass floor and walls I have substituted a plaster of Paris base and sides cast in a single piece. The dry plaster was mixed with a pale reddish pigment and, after being cast and thoroughly dried, was coated with varnish to prevent undue absorption of water from the damp sponges. These nests are very easily made, are almost as light and portable, and quite as satisfactory in all other respects as the original Fielde nests.

My simple experiments, which consisted in introducing female ants into small colonies of workers of alien species, are open to certain objections which may be briefly considered. *Ex hypothesi* I should have used either incipient or depauperate, that is, very small wild colonies of workers, and fertilized females that had just descended from their nuptial flight, or had passed a few days roaming about the country thereby ridding themselves of more or less of their parental nest-odor. It may be contended, furthermore, that the experiments should have been performed under conditions permitting of the voluntary escape of females that failed of an amicable reception among the alien workers. None of these conditions could be realized for obvious reasons. Although young fertilized females of the various species considered in this paper are occasionally seen running over the ground just after the nuptial flight, one cannot rely upon obtaining such specimens of a particular species when they are wanted, and a systematic search for them would consume no end of time and patience. Incipient and depauperate nests, too, become as rare as hen's teeth as soon as one begins to search for those of a particular species. I was compelled, therefore, either to adhere rigidly to the conditions implied in the hypothesis concerning the founding of colonies by *Formica* species of the *rufa*, *exsecta* and *sanguinea* groups, and plan the work for several summers after locating colonies and studying the exact dates of the nuptial flights, or to use unfertilized and artificially deälated females and small numbers of workers taken from adult colonies of other species. I chose the latter course and soon found that the results were very nearly the same as would in all probability have been obtained by the former with its almost insuperable difficulties. Contrary to what might be expected, the act of fecundation has little effect on the subsequent instincts of the females, and a small number of workers when isolated from a flourishing colony, either through what may be called an awareness of lack of backing by numbers, or for some other reason, are often as cowardly and conciliatory as the firstling workers of incipient colonies. And finally, unless the experiments were to be performed in the open country, where they would hardly be practicable, it was necessary to compel the females to reveal as much as possible of the resources of their instincts by preventing their escape from the alien workers. In some cases the nests were large enough to enable the females to keep at a safe distance from the spot on which the workers had settled with their cocoons.

OBSERVATIONS AND EXPERIMENTS.

1. **Formica difficilis** *Emery* var. **consocians** *Wheeler.*

Owing to the lateness of my arrival in Colebrook during the summer of 1904, I failed to find the males and virgin females of *F. consocians* and was therefore unable to complete my observations on the habits of this interesting ant. During the past summer I arrived as early as June 27, and at once began a search which resulted in my finding not only the colonies which had been seen in former years but several additional ones in different localities. The species is, however, by no means common. It certainly occurs only in stations occupied by colonies of its temporary host, *F. schaufussi var. incerta* Emery. Unlike several members of the *rufa* group, *consocians* is monodomous, that is, its colony is confined to a single nest. The sexual individuals, which were found only in the larger colonies, began to hatch July 3 to 5. The males seemed to make their appearance earlier than the females, and the summer brood of workers did not appear till after the latter had hatched. Most of the colonies contained both sexes, but one was always much more abundant than the other. The opened nests present a very pretty appearance. The males are deep black, the females rich fulvous yellow with black wings, the workers have a dull orange red head and thorax and an opaque brown and somewhat glaucous gaster. The small size of the females and their parasitic habits would lead one to suppose that they must be produced in greater numbers than the much larger females of *F. subsericea*, *schaufussi*, etc., and this is certainly the case. Some of the colonies must have contained as many as 800 females, since fully half that number hatched from part of the cocoons taken from a single colony and kept in one of my artificial nests. As the weather during the past July was extremely warm, the males and females hatched and matured in this and other artificial nests with great rapidity. They became very actively phototropic just before July 20 and, had they been permitted, would have escaped into the air. That this was approximately the date for the nuptial flight for some of the colonies during 1905 was also shown by an observation on a wild colony of *F. incerta-consocians* found July 22 under a stone fully half a mile from any locality in which I had previously seen *consocians* colonies. This colony consisted of some fifty *incerta* workers, about a dozen callows and a number of worker cocoons. The most careful search failed to reveal a female of this species, but instead there was a fine deälated female of *consocians* that must have been very recently adopted. As all the cases of a similar character recorded in my former paper[1] were found later in the summer, and as males had been found as late as Aug. 12 during 1901, I conclude that the season of 1905 was unusually far advanced. In all probability the nuptial flight commonly takes place somewhat later, perhaps during the last days of July or the first days of August.

While the observations recorded in my former paper leave little doubt that *F. incerta* is the normal temporary host of *F. consocians*, they do not, of course, exclude the possibility of other species assuming this rôle under certain conditions or in certain localities. To test this matter I introduced artificially deälated females of *consocians* into small colonies of workers belonging to different species of *Formica*. The results, which, with a single exception, were all negative, may be briefly stated.

Experiment 1. Aug. 10, 6 P. M. A female *consocians* was placed in a nest with 40 workers of *F. subpolita var. neogagates*. Several of the latter at once seized her by the legs and antennæ, dragged her about, and although they were individually inferior in stature, succeeded in killing her by the following morning. A similar experiment with a smaller colony of *neogagates* workers gave the same result.

Experiment 2. July 6. A female *consocians* introduced into a small colony of *F. subsericea* workers was dispatched by a single large worker as soon as she was encountered.

Experiment 3. July 10. A female *consocians* placed in a nest containing a few medium sized workers from a young colony of *F. exsectoides* was at once seized by one of the workers. She managed to get the worker's fore leg between her mandibles and pinched it till she was released. She then ran frantically about the nest, trying to escape, but was at once seized by another worker, that proceeded to saw off her head. This was not quite accomplished, but the female died on being released a few minutes later.

Experiment 4. July 11, 11.30 A. M. Placed successively two *consocians* females in a nest containing 17 workers of the typical *F. schaufussi* and several worker pupæ. The first female was at once attacked and killed by a worker that used both her mandibles and formic acid batteries. The second female was attacked jointly by two workers, but managed to escape to the light corner of the nest, where she was found lurking at 2 P.M. By 4 P.M. she had been discovered and killed. A very similar experiment with another small colony of *schaufussi* gave the same result.

---

[1] A New Type of Social Parasitism among Ants. Bull. Am. Mus. Nat. Hist., Vol. XX, Oct., 1904, pp. 350, *et* seq.

Experiment 5. July 11, 11 A.M. A female *consocians* was placed in a nest containing 12 workers and a queen of *F. schaufussi* var. *nitidiventris* together with several worker cocoons and larvæ. The female *consocians* was ignored by the female *nitidiventris*, but not by the workers, who kept dragging her about by the legs and antennæ. July 12 to 14 the female was being pulled away from the *nitidiventris* queen and brood by the workers but kept returning to them whenever she was released. At 1.40 P.M. on the latter date she was found dead. Two more *consocians* females were at once placed in the nest. Not only were these also attacked and pulled about by the workers, but they began to attack each other although before deälation they had been living amicably side by side in the parental nest. July 15, 7 A.M. One of the *consocians* was dead; the other kept lingering about the brood, apparently seeking adoption. July 16 the same behavior was observed and was interrupted from time to time by the workers pulling her away by the legs and antennæ. On July 17, 7.30 A.M., she was found dead in one corner of the nest. At 8.45 A.M. a fourth female was introduced. From time to time till 4 P.M. the usual tugging and persistent returning of the female to the stack of cocoons were observed. July 18, 1 P.M. the *consocians* female was resting peaceably beside the *nitidiventris* queen on the pile of cocoons. No attacks on the former were seen during the afternoon, but on the following day she was repeatedly pulled away by the workers. July 20, 6.30 A.M. she was lying dead in a corner some distance from the brood. At 8 A.M. a fifth female *consocians* was introduced. At 6.30 P.M. she was resting with the brood and *nitidiventris* queen. Although the colony was carefully watched on the following days, from July 21 to 26, no attacks on this female were observed. She had been adopted without remonstrance and behaved and was treated as if she had always been a member of the colony.

This experiment indicates that *F. nitidiventris*, though very closely related to *incerta*, does not readily adopt *consocians* females, but that this can be brought about by keeping the colony constantly supplied with these females. In the experiment four were killed before one was adopted. The perfectly indifferent attitude of the *nitidiventris* female toward the intrusive *consocians* is very suggestive. It is possible that the presence of the mother of the workers may have delayed the adoption of a stranger. The var. *nitidiventris* seems to be very rare in the Litchfield Hills. At any rate, I could not find another colony on which to try the experiment without a *nitidiventris* queen.

The results of experiments 1 to 5 seem to eliminate several species of *Formica* from the list of possible hosts of *F. consocians*. It is so improbable that the other members of the genus occurring at Colebrook, namely *F. integra*, *nepticula* and the different forms of *sanguinea*, can be temporary hosts of *consocians*, that I have not thought it necessary to consider them in this connection. *F. incerta*, therefore, remains as the only host species.

The experiments recorded in my former paper were avowedly incomplete, since they were all performed with *consocians* females that had, during some portions of their lives at least, been living with *incerta* workers. It was necessary, therefore, to observe the behavior of *incerta* in the presence of recently hatched *consocians* females. From a number of experiments performed with such females during the past summer I select a few of the more suggestive.

Experiment 6. July 21, 4.30 P.M. An artificially deälated *consocians* female was placed in a nest with 20 *incerta* workers and several worker cocoons taken from one of the most vigorous colonies found during the entire summer. he workers were unusually large and more like the workers of pure *schaufussi* but with the coloration and pilosity of *incerta*. The female seemed disinclined to approach the workers which were brooding over their cocoons, but she moved towards them when the illumination of the chamber was reversed. She was at once seized by a worker and showered with formic acid. She escaped to a corner of the nest. By 5.15 P.M. she had returned, mounted the pile of cocoons and was licking the workers, who were submitting to this treatment as if it were a matter of course. A few moments later she fed one of the workers and then kept alternating between feeding and caressing the *incerta* with comical rapidity and perseverance. The colony was watched till 7.45 P.M. but no further hostilities were seen. July 22, 7 A. M. The previous night had been cold and the female seemed to have passed it hanging from the roof-pane in a corner of the nest. Later as it grew warmer she returned to the *incerta* and their brood, caressed and fed the workers and took food from their lips. Only once during the day was a worker seen to tug for a few moments at one of her antennæ. On the four following days (July 23 to 26) no hostilities were observed. The *consocians* female had been definitively adopted.

Experiment 7. July 8, 4 P.M. Three artificially deälated female *consocians* (Nos. 1, 2, and 3) were introduced into a nest containing 20 *incerta* workers and numerous worker and male cocoons. About half of the workers were callows. Very little hostility was displayed towards the intruders. July 9, 8 A.M. One of the females (No. 1) was found dead in the light chamber and the remaining pair were quarrelling with each other. On separating, one of them mounted the pile of cocoons and began assiduously to feed and lick the callows. This female was finally pulled away from the brood by an *incerta* worker. At 11.35 A.M. the two females were seen rolling about in a fierce scrimmage. They finally separated no worse for the struggle and one of them was dragged about the nest by an *incerta* worker. The other went to the pile of cocoons but soon returned and pounced on the dragged queen, biting her thorax and petiole and then pulling her legs till she squirmed with pain. The female then released her hold and a worker *incerta* came up and pinioned her by the hind leg. At 1.15 P.M. the two females were again detected in the act of fighting, while one of them was being simultaneously pulled by an *incerta*. At 5 P.M. one of the females (No. 2) was found dead in a corner of the nest. At 6 P.M. two more females (Nos. 4 and 5) were introduced and were soon being pulled about the nest by the *incerta* workers. They were also set upon by female No. 3, who fought them with greater animosity than she had displayed towards Nos. 1 and 2. At 6.30 P.M. all three females were fighting one another, while a single *incerta* was tugging one of them (No. 4) by her antenna. Then another *incerta* fell upon the same female and while she was being stretched out between them, one having hold of her antenna, the other of her hind leg, females Nos. 3 and 5 came up and savagely bit at nearly every part of her body. Then the two free females faced about and fought with each other, even making use of their formic acid batteries. 8 P.M. Fighting still continued among the three females but none of them seemed to be injured. July 10, 6 A.M. One of the females (No. 4) was dead in a corner of the nest. Nos. 3 and 5 were still fighting but were not molested by the *incerta* workers. July 11, 4.20 P.M. Two more females (Nos. 6 and 7) were introduced. At 5.30 P.M. female No. 3 was fighting No. 7, which had been pinioned by an *incerta*. Female No. 6 was ingratiating herself with the callows and workers. July 12, 11.30 A.M. Female No. 3·had lost one antenna during the night; the remaining females (5, 6, and 7) were at peace with one another. At 4.30 P.M. three more females (Nos. 8, 9 and 10) were introduced, so that there were seven altogether. July 13, 8 A.M. Two more females were dead (Nos. 9 and 10). One of them was being carried about by an *incerta* worker. Another died at 1.45 P.M. July 14 and 15 no struggling of the females either with one another or with the *incerta* was observed. Workers of *incerta* were hatching in great numbers. July 16, 1 P.M., 9 deälated and 8 winged females were introduced, making altogether 21 females in the nest. July 17, 7 40 A.M., all these females were alive and in good condition. There were no hostilities. Even the wings were unruffled. July 18, 7 A.M., 6 deälated females were dead and had been deposited in the light chamber. There was some pulling of the remaining females by the workers. A few of the former had lost some or all of their wings. In some the tips of the wings had been torn off, indicating hostilities. 3.30 P.M. One of the deälated females was being pulled by three *incerta* while another female was trying to saw off her gaster. Thereupon there was a struggle between two other females. In the light chamber some of the winged individuals were quietly eating sugar while the remaining deälated females were feeding and licking the callows or brooding over the cocoons. Many male *incerta* began to hatch. July 19, 7 30 A.M. There were a few struggles between females and workers. Both the *incerta* males and winged *consocians* females were very restless and ran about the light chamber. At 12 M. three deälated females were fighting with one another like three angry viragos. July 20. There were no dead females. The winged individuals still tended to congregate in the light chamber even when they had lost all but the basal portion of their wings, while the deälated individuals stuck to the brood and lavished their attention on the callows and any adult workers that seemed inclined to be licked and to exchange ingluvial food. There were no important changes in the nest during July 21 and 22. July 23, 1 P.M. A single deälated female was found dead on the refuse heap. During July 24 to 26 perfect amity pervaded the nest. On the latter date, when I was compelled to close the experiment, only one of the females still retained wings and all of them were busy licking the workers and being fed by them. These females no longer visited the manger. All of the females used in this experiment were sisters taken from the same wild colony.

Experiment No. 8. July 6, 5 P.M. Four deälated *consocians* females (Nos. 1, 2, 3, and 4) were introduced into a nest containing a dozen *incerta* workers and many larvæ and pupæ taken from a flourishing wild colony. These females at once ascended the brood-pile, begged for food, and commenced licking the *incerta* workers. In the evening one of the females was seen to attack another and drag her around the nest. July 7, 8 A.M. Three of the *consocians* (Nos. 1, 2, and 3) were dead and had been deposited in the light chamber. The fourth was living peaceably with the *incerta*. Two more females (Nos. 5 and 6) were placed in the light chamber. As soon as they entered the dark chamber and attempted to ascend the brood-pile they were attacked by female No. 4 and so persistently persecuted that they fled to the light chamber, leaving their irate sister in full possession of the *incerta* colony. The two banished females returned to the dark chamber but were again driven out. Meanwhile the *incerta* workers remained quite indifferent to these bickerings and kept nursing their larvæ and cocoons. Females Nos. 5 and 6 were again returned to the dark chamber and the entrance was closed with earth. No. 4 now attacked No. 5 and bit her thorax so severely that she was injured and kept dropping on her knees when she tried to walk. Then No. 4 began to drive No. 6 around the nest, tweaking her legs and antennæ and trying to cut off her head till she managed to escape to the light chamber by burrowing through the earth in the entrance. Females Nos. 5 and 6 were again returned to the dark chamber and the entrance was plugged with cotton. Late in the evening all was quiet in the nest, the three females having come to rest in different parts of the chamber. No. 4 was busily licking the *incerta* workers. July 8, 8 A.M. Females Nos. 5 and 6 were dead and No. 4 was in undisputed possession. Two more females (Nos. 7 and 8) were introduced and the plug was removed from the entrance, No. 4 made no effort to attack them, but they were pulled about a little by the *incerta* workers and finally escaped into the light chamber. The entrance was again closed and they were returned to the dark chamber. They ran about but showed no inclination to associate with the *incerta* or with female No. 4 though they were very conciliatory whenever they happened to meet one of the workers. They lapped the surface of the sugar with avidity. July 9, 8 A.M. Female No. 7 was found dead in the manger. Female No. 8 was hovering around the edge of the brood-pile. There must have been some fighting during the day, as at 7 P.M. female No. 4 had an injured hind leg and walked with difficulty. She was dead at 8 P.M. Two more females (Nos. 9 and 10) were introduced. Females 8, 9, and 10 quarrelled among themselves. No. 8 was seen to move the cocoons whenever the chamber was illumined. This was the first and almost the only time one of these females was seen to pay any attention to the cocoons of her hosts. There were no battles between the females and workers. Late in the evening females Nos. 9 and 10 were feeding and caressing each other. July 10, 6 A.M. The three females 8, 9 and 10 were huddled together, licking and intergurgitating with the *incerta* workers. A little pulling of these females by the workers was observed from 1 to 5 P.M. July 11 there was peace and this remained unbroken till 5 P.M. on the following day (July 12), when six more artificially deälated *consocians* females were introduced, making a total of nine in the nest. The six new females were all placed in the light chamber, but as soon as they could find the opening they entered, crossed the dark chamber and at once ascended the pile of cocoons where the *incerta* workers were brooding. There was a little rather half-hearted resistance on the part of the *incerta*, but after a few moments all nine females were peaceably elbowing each other on the brood-pile while they cleaned one another and the *incerta* and fed and received food from the latter. At 7 P. M., however, two of the females engaged in a fierce combat, while all the others remained undisturbed. One of the pair escaped, whereupon the victorious individual went up to another female and began to pick a quarrel with her. In these combats one of the females always tried to bite through the other's thorax. July 13, 8 A.M. two of the females were dead, but one of them had evidently died from an injury received while she was being placed in the nest. The remaining 7 females were to all appearances living in perfect amity, with the *incerta* and with one another. At 12 M. three deälated and three winged females were introduced, making a total of 13. No hostilities were observed during the remainder of the day. July 15. One deälated female died during the course of the morning. The three winged females sought the light chamber, where they huddled side by side on the lower surface of the roof-pane. They showed no interest in the *incerta* or in their deälated sisters. From July 16 to 26 no hostilities were observed. The dozen females had been adopted by the *incerta* and had settled their differences with one another. The winged females retained all their wings and exhibited the behavior peculiar to their sex before deälation, till July 26, when I had to close the experiment. The females used in this experiment were taken from two widely separated wild colonies.

These experiments disclose several interesting facts:

First, it is clear that, though the introduced *consocians* females are recognized as aliens, they nevertheless often succeed in overcoming the hostile instincts of the *incerta* and acquiring adoption. When *consocians* females are persistently kept before the *incerta*, the latter become reconciled to their presence and will tolerate a considerable number of them in the nest.

Second, there is a pronounced tendency for the females to war on one another. These struggles are much fiercer than those between the *consocians* and the *incerta*. This fact is surprising because the females used in the above experiments were usually taken from the same colony and had been amicably snuggling together as daughters of the same mother before they were introduced to the *incerta*. I am inclined to believe that this mutual hostility of the females is a useful adaptation to prevent, as it must in a state of nature, the over-peopling of an *incerta* nest with these parasites. If this is the case it is perhaps difficult to understand why the hostility subsides and even ceases altogether when the number of females in an *incerta* colony is artificially augmented. Perhaps this dog-in-the-manger instinct on the part of the *consocians* is still in process of development, or being controlled or rendered in part unnecessary by the unwillingness of the *incerta* workers to receive these females into the colony. At any rate, a second female entering an *incerta* nest must meet with greater opposition than the first, since she must overcome both the hostility of the *incerta* and that of the adopted *consocians*.

Third, the above experiments show very clearly that mere artificial deälation at once produces an interesting change in the instincts of the female. She becomes forthwith negatively phototropic, less inclined to feed herself, and shows great interest in the *incerta* workers. In other words she behaves as if she had been fertilized, and, instead of resting or moving indolently about the nest, seems to have suddenly awakened to an appreciation of thes erious tasks of her existence as the mother of a future colony.

While the preceding experiments show that *consocians* females fresh from the maternal nest are quite readily adopted by *incerta* workers which to all appearances have had no previous experience with these parasites, it is clear that the possibility of such experience has not been eliminated. In other words, it may be objected that the *incerta*, having lived in a locality inhabited by *consocians*, must be familiar with this species and, for aught we know to the contrary, may have been hatched and reared in or very near a colony of the parasitic species. The cogency which any one unfamiliar with the ways of ants might find in this objection is completely destroyed by the two following experiments, which at the same time strengthen the conclusions drawn from my previous observations:

Experiment 9. July 5. A number of worker pupæ and a just hatched callow from a wild *incerta* nest were isolated. By July 7 eleven workers had hatched and had reached maturity by July 10. At 12 M. on the latter date a single deälated *consocians* female was introduced into the nest. She ran about a moment till she stumbled on the group of workers brooding over their cocoons. She touched the head of one of them and at once began to quicken the vibrations of her antennæ, while the remaining workers clustered around her and responded with a similar acceleration of their antennal beats. Only one worker showed a trace of hostility by opening her mandibles. The *consocians* female at once fell to licking one of the workers, while the others turned away apparently satisfied that the female was good company. Though the nest was watched repeatedly on this and the following day (July 11), no sign of hostility could be detected. July 12, 2 P.M. Two more females were introduced. They were carefully scrutinized, pulled a little and then licked by the workers. They stood their ground and at once began to caress the *incerta*. At 4 P.M. four more females were introduced, making seven altogether. Like the others they were received with barely noticeable signs of hostility and much licking, and forthwith settled down on the cocoons as members of the colony in good standing. At 7 P.M. two of the females were quarelling with each other, while the others were quietly brooding over the cocoons. July 14. During the morning there was perfect peace in the nest. At 12 M. four winged females were introduced. They were slightly pulled but soon adopted. The colony remained in the same peaceful condition till July 23 except that on July 19 the winged females became very restless and ran about the light chamber as if impatient to take their nuptial flight. At 2 P.M. July 23, ten more deälated females were added, bringing the total number up to 21. These females were adopted by the *incerta* without hesitation, but there was some bickering between the females from 3 to 5.30 P.M. There was perfect peace, however, on the following days from July 24 to 7 P.M. July 26, when the experiment was closed. All the females employed in this experiment were sisters from the same colony.

In this case the *incerta*, of course, could have had no previous experience with *consocians*. Although the weather was very warm during the first days of the experiment it occurred to me that the workers might not have reached maturity in three or four days and that the introduction of the females should have been postponed for at least twice that period of time. On returning to Bronxville, N. Y., during August I therefore repeated the experiment with this in mind. A number of *consocians* females had been brought from Colebrook and were introduced to *incerta* workers bred from cocoons taken from nests at Bronxville in a locality where the typical *difficilis* is very rare and its variety *consocians* is not known to occur.

Experiment 10. Aug. 17, 6 P.M. an artificially deälated *consocians* female (No. 1) was placed in a nest with nine *incerta* workers, all of which had hatched in isolation 6 to 8 days previously, and a number of worker cocoons. The workers threatened the female with opened mandibles but did not seem courageous enough to attack her. She kept approaching and touching them with her antennæ. Aug. 21, the female contrived to escape from the nest during the night. Another (No. 2) was introduced at 6 P.M. There were now 12 *incerta* workers, three having hatched since Aug. 17. She was seized by three workers and pulled about. They also bent their gasters forward between their legs and deluged her with formic acid. One worker dragged her to the manger and tried to throw her into it. She freed herself but seemed to be lame. She continued, however, to accost the workers with rapidly vibrating antennæ and without signs of fear or resentment. The workers were unrelenting in their attacks. They seized the poor female with a jerking, almost vindictive movement. She mounted the brood-pile and stood her ground while the workers kept nibbling at her body and legs. Some of them licked her from time to time. By 6.15, although she was still threatened by some of the workers, most of them passed without tweaking her. Several of them were evidently much interested in her. At 6.30 she began to lick the heads and backs of the workers with great assiduity. Some of them still pinched her legs from time to time. At 7.10 P.M. she showed signs of weakness, and died soon afterwards. At 8 P. M. another female was introduced. She was at once threatened by several workers and pulled across the chamber. She was soon released, however, and ascended the brood-pile, where she was attacked by a callow. She was seen to feed one worker and to attempt to repeat the same performance with a second when she was attacked by a third. The proffered droplet was distinctly seen at the tip of her tongue while she opened her mandibles to their fullest extent. At 8.45 P.M. she was passing from one worker to another, licking, feeding and being fed. At 9 P.M. there was very little bickering. The female seemed to be quite at home on the stack of coccons and was being licked and fed by the workers. Aug. 22, 7 A. M. she was still alive and resting on the brood-pile, which the ants had moved to a different part of the nest. A worker pulled her by the antenna but soon released her. Two more callows were hatching, so that by 6 P.M. there were 14 workers in the nest. During the following days, from Aug. 23 to 27, there were few or no hostilities, so that female No. 2 seemed to be definitively adopted. Aug. 27, 11 A.M. another female (No. 3) was introduced. For some time she remained unnoticed, resting on the towelling at the edge of the chamber. By 12 M. she had entered the cluster of workers and brood and was being pulled by the legs and antennæ. She stood her ground and offered food but was seized by the mandibles. At 12.30 P.M. female No. 3 had a lame antenna, and at 1.35 a fierce combat was in progress between the two females, female No. 2 being the aggressor. By 6 P.M. peace was restored and by 8.35 female No. 3 had been adopted. Two more females (Nos. 4 and 5) were introduced. No. 3, and somewhat later No. 4, was attacked and pulled by three workers. There was also some fighting between Nos. 2 and 3. The workers soon began to lick No. 4. Aug. 28, 7 A.M. Female No. 3 was dead. She had probably been injured by the tweezers during her introduction into the nest. Three more females (Nos. 6, 7 and 8) were introduced. They were threatened and pulled a little by the workers. At 8 P. M. there were lively combats between pairs of females. From time to time these begged the workers for food. Four more females were introduced, making a total of ten. 9 P.M. There was much fighting between pairs of females and those latest introduced were being pulled by the workers. As many as three pairs were fighting at the same time. While fighting two females met face to face with open mandibles and made rapid lunges at each other, trying to grab the opponent's antenna or fore-leg. When one of them was hard pressed she backed but kept facing her opponent. While in this position they often bent the gaster forward between their hind legs and discharged formic acid into each others' faces. The workers paid no attention to these combats. Aug. 29, 7 A.M., three females were dead and the remaining seven were fighting with one another. On the following days (from Aug. 30 to Sept. 2) six of the females remained alive and kept fighting from time to time. Peace was restored Sept. 3 and continued till Sept. 9. During this period there was a conspicuous tendency for the six females to huddle together in the midst of the *incerta* workers. Sept. 10, 8.30 A.M. six more females were introduced. They were all received with signs of hostility on the part of the *incerta*. One of them was attacked by four workers simultaneously. The new females had all been put in the light chamber, but they soon entered the dark chamber of their own accord. Within twenty minutes most of the attacks on them by the workers had subsided and by 9 P.M. they were being licked and fondled by their hosts. Some fighting between the older and more recently introduced females took place and increased in frequency and violence till 6 P.M. One of the females died Sept. 11, another Sept. 18, and only 7 remained alive Sept. 19. During this time there was more or less fighting between females but not between females and workers. Sept. 22, 7.30 A.M. six more females were placed in the nest. These were amicably received by the workers but were attacked by the old females. At 7 P.M. several couples were chasing each other around the nest. By Sept. 23 the fighting had become much less frequent and violent. Oct. 1 there were still 13 living females in the nests and this number was maintained till Nov. 30, when 11 of them and some of the *incerta* died because the nest was permitted to dry out. The remaining two females were still living, Feb. 6, 1906. All the females used in this experiment were sisters.

The ease with which the *consocians* females are adopted by *incerta* workers is in marked contrast with the refusal of *consocians* to receive females of their own species from other colonies and the refusal of the workers of either species to adopt workers of the other.

Experiment 11. July 6, 12 M. Into a colony consisting of several hundred *consocians* workers two deälated *consocians* females from another colony were introduced. They were suddenly and violently seized by the workers and dragged into the dark chamber, where they were enveloped by a mass of workers that showed as much active interest in them as they had in house-flies introduced into the nest: they licked and bit them persistently. One of the females had been killed by 4 P.M. and the other was found dead the following morning. July 9 a winged and a deälated female, together with two workers from the same colony, were introduced. The workers were at once adopted but the females were soon killed. July 10 two more deälated females, added to the colony at 8 P.M., were killed within an hour. July 13, three deälated females were introduced. July 14, 6.30 A.M. two of these were found dead. July 16 the remaining one was still living, at 7.30 A.M. At 1.30 P.M. three more females were introduced, so that there were four altogether. July 18 one of these had been killed. The three females were permitted to live till July 20, when all had been killed and thrown into the light chamber. Four more added July 21 were killed by 8.30 A.M. and by July 23 another had been dispatched, leaving only one alive. This female also died some time between July 26 and Aug. 1.

Experiment 12. July 10, 4.30 P.M. Three *consocians* workers were placed in the dark chamber of a nest containing a number of *incerta* workers and cocoons and two *consocians* females that had been adopted. The intruders were fiercely attacked by the *incerta* and ran wildly about the nest trying to escape at the corners of the chamber. Again and again three or four of the *incerta*, that seemed to be much excited by the peculiar odor of the *consocians*, would seize a worker and pull its legs and antennæ. At 5.40 P.M. the *consocians* workers had managed to escape into the light chamber, whither they were followed by a few *incerta*. These at once began to close the entrance to the dark chamber with pellets of earth and thus prevented any further visitations.

The views of the phylogenetic origin of slavery advanced by Wasmann and myself almost simultaneously[1] suggested some experiments to ascertain whether there is any tendency for adult *consocians* colonies to seize the larvæ and pupæ of *incerta* for the purpose of eating them or rearing them as auxiliaries. In nature there is absolutely nothing to indicate that these two species ever form mixed colonies except under the conditions already described in this and my previous paper, although colonies of both species were sometimes found very close together; often, indeed, in the same stone-pile. The two following experiments certainly show an unusually pronounced aversion on the part of either species to adopting the young of the other.

Experiment 13. June 28 a number of cocoons and larvæ from a large *consocians* colony were placed in the light chamber of a nest containing about twenty *incerta* workers with a *consocians* female that they had adopted. The ants removed the larvæ to the dark chamber, but left the cocoons untouched and exposed to the light for eight days till I removed them from the nest. The *consocians* larvæ were gradually eaten.

Experiment 14. June 30 one hundred *incerta* cocoons and 16 larvæ were placed in the light chamber of a nest containing a number of *consocians* workers. The larvæ and thirteen cocoons were slowly taken into the dark chamber, the remaining cocoons were ignored. The larvæ were eaten and the cocoons that had been carried away were restored to the light chamber. None of the *incerta* young hatched, and had to be removed when the nest was cleaned five days later.

A point on which I have been unable to throw much light during the past summer is the emancipation of the young *consocians* colony from the colony of *incerta* by which it has been reared. That this emancipation takes place by the gradual and natural death of the *incerta* workers rather than by the sudden emigration *en bloc* of the *consocians* is indicated by the following observation, which is similar to those made on nests No. 15 and 16 of my former paper. July 16 I found under a large stone on the eastern slope of Mt. Pisgah a small pure colony of *consocians* comprising about fifty workers, nearly all of small stature, a few nearly full grown and three packets of young larvæ and a fine female. The nest architecture, however, was unmistakably of the pure *incerta* type although no workers of this species were present. There could be no doubt that this represented a *consocians* colony in its second or third year. It corresponded exactly with the *truncicola-fusca* nest found by Wasmann during March, 1905.

---

[1] An Interpretation of the Slave-making Instincts of Ants. Ursprung und Entwickelung der Sklaverei bei den Ameisen. Biol. Centralbl., 15 Feb. bis 1 Mai, 1905, p. 291.

Before concluding what I have to say about *F. consocians* I would insert a few notes on three colonies that have been kept in artificial nests since August, 1904. They may be designated as Colonies A, B, and C.

Colony A consists of some 500 *consocians* workers nearly all of which hatched in a Fielde nest from cocoons taken from a large colony during August, 1904. Although kept in a cool room (50°–60°F.) all winter, the workers began to lay eggs in great numbers as early as the first of February. The nest was white with eggs during February and March, and many larvæ began to hatch during April. The nest was unfortunately much neglected during May while I was absent in Arizona and many of the eggs and young larvæ had been eaten. On my return June 3 I found 16 pupæ, all males and of normal size and structure but not enclosed in cocoons. Most of these hatched during July.

Colony B, which was installed Aug. 19, 1904, consists of three deälated *incerta* queens and a few workers together with a fertile *consocians* queen which they had adopted.[1] The four females have lived together in perfect amity throughout the year. From time to time eggs and young larvæ appeared in the nest, but they were always eaten, so that I was unable to determine which species produced them. By July 1 all but one of the workers had perished. From this time forth the *incerta* females took entire charge of the young, carrying them away in their mandibles or standing guard over them when the nest was exposed to the light. The *consocians* female never exhibited the slightest interest in these young. During July, 1905, this diminutive colony was given a few *incerta* cocoons which soon produced workers. These were, of course, adopted by the queens, who now no longer looked after the young. Up to the present writing (Oct. 1) the colony has not succeeded in bringing any of its larvæ to maturity.

The observations on this colony together with those recorded above for *F. nitidiventris* (p. 52) show that the presence of the queens of the host species may be a matter of indifference in the adoption of a *consocians* female. If such a queen is present in a wild colony at the time it receives the *consocians*, she must be dispatched by her own workers under conditions as yet unexplained.

Colony C. This colony, also installed in August, 1904, consisted of a fertilized *consocians* female and about 40 *incerta* workers. It passed the winter successfully. The gaster of the female increased greatly in size and took on a whitish hue from the eggs and fat-body shining through the integument. During the spring and summer of 1905, eggs and young larvæ were continuously present in the nest, but none of them ever matured. This colony died of neglect during September, 1905.

The only myrmecophiles seen in the nests of *F. consocians* at Colebrook, Conn. were the larvæ of an undetermined species of *Microdon*. These were found July 7 in a single nest under a large stone lying on a lot of twigs, grass-roots, etc. Three larvæ were seen at this time, one nearly mature and one only about a quarter grown. On the twigs and lower surface of the stone there were some twenty empty puparia from which the flies had already escaped. The three larvæ were placed in a Fielde nest containing several hundred *consocians* workers. The two older ones at once applied their flat creeping-soles to the glass bottom of the nest and with their hard rough backs resisted the attacks of the workers. The small larva was not so successful. The ants turned it over on its back and for two days kept licking and biting it till it was killed and reduced to a small granule. The two large larvæ kept crawling slowly about the nest. They raised the anterior end of the body a little distance from the glass surface and moved the small pointed head, which is just beneath it, from side to side apparently in search of food. They showed signs of uneasiness when exposed to strong light. They remained in good condition till Aug. 23, when one of them disappeared. It had probably been eaten by the ants. The other lived till Sept. 10. Some days previously it had begun to shrivel, and finally dried up without losing its hold on the glass. I have failed to ascertain the nature of the food of these larvæ. July 25 I again visited the wild *consocians* nest but found that the ants had moved away. On the twigs there were two more half-grown but rather emaciated *Microdon* larvæ which had been left behind by the ants. These together with a couple of old puparia are shown in Pl. X, Fig. 2. The fact that these larvæ were so emaciated, and died soon after they were placed in the same Fielde nest with the others, shows that the presence of the ants is in some way essential to the well-being of these singular synœketes.

---

[1] See A New Type, etc., pp. 354, 355.

2. **Formica difficilis** *Emery*.

The typical *F. difficilis* like its variety *consocians*, is a rare and local ant. Judging from my experience during the past summer it is even rarer then its variety, since I have hitherto been able to find only two colonies, one near Mt. Vernon, N. Y., the other at Bronxville, N. Y. Each of these was nesting under an isolated stone. The ants of the Bronxville colony, which was found Aug. 12, had heaped up a quantity of dead leaves, bits of grass, etc., and were guarding, partly in this pile of débris and partly under the stone, a great number of worker pupæ. Dozens of these were naked, a condition which is rare in ants of the *rufa* group and had not been observed in the colonies of the Connecticut variety. The minim workers in this colony were very dark and smaller than the smallest commonly found in the *consocians* colonies. They measured only 3–3.5 mm. while the largest workers were 5.5–6 mm. in length. The nest was discovered too late in the season to contain males and females. Both this and the Mt. Vernon colonies were located on the sunny border of some open woods where the typical *schaufussi* and its var. *incerta* are unusually abundant. There can be little doubt that one or the other of these ants functions as the temporary host of *difficilis*. This species occurs also near Halifax in the Ramapo Mountains of northern New Jersey, where I captured a few workers attending aphides on trees at an altitude of about 800 feet. Mr. Wm. T. Davis has brought me several specimens taken at Inwood, N. Y., a locality in which the last traces of the original ant-fauna of Manhattan still linger at the northernmost end of the island.

3. **Formica nepticula** *Wheeler.*

This species, which I have described in a recent paper,[1] is of unusual interest because it has females even smaller than those of *F. difficilis;* quite as diminutive, in fact, as those of *F. microgyna* and *nevadensis*. A single colony of *nepticula* was located during August, 1904, at Colebrook, Conn., but as at that time it appeared to contain only workers it was regarded as a colony of *F. dryas* or of some form of *rufa*. June 30 of the current year when I again visited the nest, which was under a large stone banked with vegetable débris like the nests of *F. consocians*, I was surprised to find several diminutive, mostly callow females and a considerable number of cocoons all of about the same size. A large part of the colony was transferred to an artificial nest. During the first week in July many of the little females but only two males made their appearance. The workers of the season did not begin to hatch in numbers till July 9 to 21. The date of the nuptial flight is approximately July 11.

The small size of the females indicates that this species, like *consocians*, *microgyna*, *montigena*, etc., is a temporary parasite on some other species of *Formica* of the *fusca* or *pallide-fulva* groups, but we can only conjecture which of the species nesting in the same locality is used for this purpose. These species are: *F. subsericea*, *neogagates*, *incerta*, *nitidiventris*, and the typical *schaufussi*. The coloring of the *nepticula* female is remarkably like that of certain workers of three of these forms, namely: *neogagates*, *incerta*, and *nitidiventris*. The only colony of *nitidiventris* I found during the summer was used for experiments with *consocians*. The results of my attempts to get the other species of *Formica* to adopt *nepticula* females are here given in condensed form:

---

[1] New Species of Formica. Bull. Amer. Mus. Nat. Hist., Vol. XXI, 1905. p. 270.

Experiment 15. July 2, 2 P.M., a mature deälated female *nepticula* was placed in each of two *incerta* nests containing only workers and their cocoons. The presence of the *nepticula* greatly excited the *incerta*. They seized and pulled her about and sprayed her with formic acid. Their whole behavior was decidedly more vehement than on the introduction of *consocians* females. In both nests the females were found dead at 4 P.M. Essentially the same results were obtained by placing *nepticula* females in nests with workers of the typical *schaufussi*.

Experiment 16. July 5 a deälated female *nepticula* was placed in a nest with a number of *subsericea* workers. She was at once seized and in a few moments terribly mutilated. One of her antennæ was extirpated, one mandible was completely torn from its socket, the funiculus of the other antenna was cut off and some of her legs were cut in two, so that she died in a few moments.

Of the following three experiments with *F. neogagates* one terminated with the adoption of a female *nepticula* :

Experiment 17. July 7, 8 A.M., four deälated *nepticula* females (Nos. 1, 2, 3, and 4) were placed in a nest with 12 small *neogagates* workers and a number of nude pupæ. These workers had been taken from a young wild colony consisting of not more than 50 small workers and their queen. The *nepticula* were vehemently attacked. Female No. 1 was killed during the afternoon; two others (Nos. 2 and 3) wandered about the nest, ate the sugar in the manger and fed each other, but gave no heed to the *neogagates* workers which had collected their pupæ and were occupying a corner of the nest. The fourth female, however, remained with the *neogagates* workers and was seen to adopt the same conciliatory tactics towards them as are shown by the *consocians* females towards the *incerta*. The callows were beginning to hatch from the nude pupæ. July 8, 8 A.M., a worker tried to drag No. 3 and then No. 4 away from the pupæ but soon desisted, whereupon the females again returned. At 11.30 A.M., another female (No. 2) was found dead. July 9, females Nos. 3 and 4 showed no desire to mingle with the *neogagates* but wandered about the dark chamber partook of the sugar from time to time and fed each other. Although No. 3 had lost an antenna she persisted in foisting herself on the *neogagates*. By noon No. 4 had also lost an antennal funiculus. Both females were being pulled about by the workers. July 11, No. 3 was dead. The pulling continued. July 12. At 6 P.M. two more females (Nos. 5 and 6) were introduced. They had escaped from the parental nest and had been flying about the room. A few minutes later female No. 5 settled near the pupæ and was being licked from head to foot by a *neogagates* worker. Then she was pulled a little by the antenna. Female No. 6 was also licked and pulled. Female No. 4 (with the injured antenna) kept returning and seeking adoption. Some of the callows which had hatched since she was placed in the nest licked her, but the older workers dragged her about. Whenever she was approached by a *neogagates* worker she crouched with flexed legs and antennæ. July 13, female No. 4 wandered about the light chamber all day, while females 5 and 6 kept lurking near the *neogagates* and their brood. At 3 P.M. female No. 5 was seen to go up to a worker and beg for food, which she received without signs of hostility. July 14, 6.30 A. M. female No. 4 was found dead. Females 5 and 6 still hung about the workers. No. 5 was seen licking a nude pupa. No. 6 was pulled about considerably but was very conciliatory. By reversing the illumination at 5.30 P.M. the *neogagates* were made to move to the diagonally opposite corner of the nest. Females 5 and 6 at once followed them and stopped within an inch of the brood, thereby showing a craving to join the colony. July 15 female No. 5 was removed from the nest, as she seemed to be too fond of the company of No. 6. The latter, now the only female in the nest, was seen, feeding a callow. At 6.30 P.M. she was found dead in the nest. Another female (No. 7) was at once introduced. July 16, 7 A.M. she was resting peacefully with the workers and their brood. No hostilities were witnessed till 4.30 P.M., when she was being pulled about. She was soon released and again pushed herself into the cluster of resting workers. Her attitude when approached by the workers was extremely conciliatory: she crouched and folded her antennæ. From July 17 to 19 she was occasionally dragged about by an antenna and then left quite unmolested for long periods or was even fed and licked by some of the workers, especially by the callows. The number of workers had risen to 21 by July 19. From July 20 to 26, when the experiment was closed, no hostilities were witnessed. Female No. 7 had been definitively adopted and was on the best of terms with the workers, which now numbered 24. During this time the behavior of the *nepticula* female was much like that of *F. consocians*: she was constantly licking or feeding the workers or being fed by them.

Experiment 18. July 14, 1.15 P.M., a deälated female *nepticula* (No. 1) was placed in a nest containing only five *neogagates* workers and some nude pupæ. These workers were of small size and had been taken from a depauperate wild colony comprising only about 15 individuals and a few male and worker pupæ. No female was found in the nest. At 1.40 P.M. the *nepticula* was fiercely attacked by a worker and driven away from the pupæ which were in a corner of the nest. She wandered restlessly about. July 15, 7 A.M. she was lurking near the workers and their brood. At 7.30 she was pulled away by the largest worker. At 2 P.M. she was dying with outstretched limbs. Another female (No. 2) was introduced. At 6.30 P.M. she was seen hanging about the workers and brood and furtively feeling of the latter. July 16 7 A.M., she was resting with the brood, at 7.20 she was dragged away by an antenna. July 17 and 18 she was resting at the diagonally opposite corner of the chamber from the *neogagates*. At 9 A.M. on the latter date she was very faint, and died at about noon. Another female (No. 3) was introduced. July 19. She persisted in hanging about the *neogagates* and their brood as if begging for adoption, but was pulled about considerably during the day. At 5 P.M. she was dead. Another female (No. 4) was at once substituted. This female remained alive in the nest till July 26 but was not adopted. She was pulled about from time to time, but nevertheless evinced a strong desire to join the little colony, as was shown by her returning again and again to the brood. It is probable that she would have been adopted had it been possible to continue the experiment.

Experiment 19. Aug. 9, 7 P.M., two mature and naturally deälated *nepticula* females were placed in a nest containing 30 small and medium-sized *neogagates* workers, most of which had been hatching in an artificial nest since Aug. 1. Each of the females was at once attacked and pulled about sometimes by as many as five or six workers at a time. They endured this treatment passively, with flexed legs and antennæ, and never attempted to bite their tormentors. Occasionally they were sprayed with ormic acid, although this severe treatment was resorted to only during the first encounters. At 9.30 P. M. one of the females was dying while being licked all over by the workers; the other was still living. Aug. 10, 7 A. M. both females were dead. Another female was introduced. She was found dead at 6 P. M. The experiment was abandoned at this point.

These experiments, while not completely satisfactory, show nevertheless that the female *nepticula*, like the female *consocians*, is very conciliatory and adaptable and has a pronounced fondness for associating with alien workers. They show that *neogagates* is not inclined to adopt *nepticula* females but may be induced to do so occasionally. It is probable that experiments 18 and 19 would have given the same result as 17 had it been possible to carry them further. The workers in the colony of experiment 19 were larger and more aggressive than those employed in experiments 17 and 18. The latter represented more nearly such incipient and depauperate colonies as *nepticula* probably selects as the most suitable in which to seek adoption. The resemblance of the *nepticula* female to a small or medium-sized *neogagates* worker is so great that she can be detected in a mixed colony only by close scrutiny. *F. neogagates* is a subboreal species and at Colebrook rarely occurs below an altitude of 1000 ft. The single colony of *nepticula* was also found at such an altitude (1400 ft.) as to indicate a connection between these species. All of these facts point to *neogagates* rather than to *subsericea* or one of the forms of *schaufussi* as the temporary host of *nepticula*.

4. **Formica rufa integra** *Nylander.*

Very little has been published on the habits of our North American forms of the holarctic fallow ant (*F. rufa*). The only form of the species which I was able to draw into the scope of my studies during the past summer was *F. rufa integra*. This beautiful insect is common in some localities in the more hilly portions of the Eastern States (above 1000 ft.), but is manifestly rarer at lower altitudes and seems to be lacking in the prairie regions of the Middle West. It prefers open, sunny glades in the woods and, so far as my observations go, occurs only in localities where its probable temporary host, *F. subsericea*, is abundant. Its colonies are often of enormous size and extend over a number of nests, each of which may contain thousands of workers. In the immediate vicinity of Colebrook, Conn., I have found two colonies, one consisting of four or five, the other of fully a dozen such nests. These are in large logs, stumps, or piles of stones, never in the shape of mounds as in the European and some of the American *rufa* forms to be considered presently. The workers collect great quantities of straws, dead leaves, pine needles, etc., and work all this vegetable débris into the crevices of the wood or between the stones. This is clearly seen in Pl. IX., Figs. 1 and 2, and Pl. X., Fig. 1. When the nests are disturbed the ants bite furiously or congregate in numbers on the surface of the nest, face the intruder, throw their heads back, and, directing the tips of their gasters forward between their hind legs, emit a shower of formic acid.

Although *F. integra* seems to be absent in the Mississippi Valley, one of its varieties—*hæmorrhoidalis*—occurs in the mountains of Colorado at an altitude of 7000–8000 feet. I have observed this form at different points in the Ute Pass and the Garden of the Gods, near Manitou. The workers are quite as large as those of the typical *integra*, but they seem to be covered with a peculiar glaucous bloom. Their habits are very much like those of the eastern form. They do not build mounds, but nest in great logs or stumps or piles of stones in the open woods. The largest nest I have seen was at Woodland Park, where the ants were occupying a prostrate pine log 12 ft. long and 1½ ft. in diameter. They had piled up débris to a height of 8–10 inches all around this log. Another nest, apparently belonging to this same colony, was in an old stump. Around this the ants had built a mass of débris 5 ft. in diameter at the base and 3 ft. high. This was connected by a run-way with another large nest in a log a few yards away. Like the true *integra*, the var. *hæmorrhoidalis* occurs in the same localities as a form of *fusca*, in this case not var. *subsericea* but var. *argentata*, a more silvery form with reddish legs and antennae.

The closely allied forms of *rufa* known as *obscuriventris*, *obscuripes*, *rubiginosa* and *melanotica* build mound nests, which in Colorado are large dome-shaped accumulations of débris 3 or 4 ft. in diameter at the base and 1 to 2 ft. high, and hence rivalling the nests of the European *rufa*. In Colorado these nests sometimes occur in colonies in the open pine woods. In the Middle West (Wisconsin and Illinois), however, the nests of *obscuripes* and *melanotica* are much smaller and of a different shape, as Father Muckermann has shown.[2]

In 1884 McCook published a number of observations[1] on the mound nests of *F. obscuripes* or an allied form of *rufa*. These nests were found scattered over the rolling country of Dakota and in Colorado to an altitude of 11,300 feet near Leadville. They ranged from 8 inches to 1½ ft. in height and from 2 to 10 ft. in diameter at the base, and were thickly covered or thatched with "bits of wood, fallen needles and broken sprigs of pine." The center of each mound was occupied by "a ball of twigs about eight inches in diameter; the sticks are longer and thicker than those used upon the roof, some of them being two and a half and three inches long. They were found unmixed with soil or any other substance. Several galleries, about one-fourth of an inch in diameter, led upward from this billet-globe to the surface, having their outlet by circular openings through the thatch." "Beneath the faggot ball a series of galleries, seven in number, extended downward to at least the distance of four and a half feet, the extent of the excavation made by Dr. De Puy." McCook believes that this faggot ball may serve as a "general nursery and common living barracks for the family." His paper also contains observations on the swarming of the ants, the destruction of their nests by prairie fires, their use in ridding garments of vermin, etc.

---

[1] The Structure of the Nests of some North American Species of Formica. Psyche, Vol. IX, June 1902, pp. 355-360.

[1] The Rufous or Thatching Ant of Dakota and Colorado. Proc. Acad. Nat. Sci. Phila. 1884-1885, pp. 57-65. 5 figs.

To any one acquainted with the magnificent adult colonies of *F. integra* and our western forms of *rufa* it must seem improbable that the queens of these species should start their families in the nests of some other ant. I am convinced, nevertheless, that this is the case and that *F. subsericea* is the species commonly employed for this purpose. The difficulties mentioned in the introduction to this paper have prevented me from securing incipient colonies of *F. subsericea*, so that I have introduced my *integra* queens to small batches of workers taken from larger colonies. Only five experiments were performed and in only one of these was the female adopted. But this would certainly be a very large proportion of success even among wild colonies. I record all of the experiments because even the least successful of them indicates that the female is inquilinous in her habits.

Experiment 20. July 4, 8 A.M. A deälated female *integra* was placed in a nest containing a dozen *subsericea* workers. She was seized and pulled about the nest by from one to three of them at a time during the entire day. July 5, the same performance was continued. The female remained uninjured. She never defended herself, but when the workers approached, crouched and made rapid supplicating movements with her antennæ. July 6. During the morning one of her hind tibiæ was torn off. She finally escaped to the light chamber, where she concealed herself under a lump of earth. July 7 she was still hiding under the earth. In the afternoon she was removed from the nest.

Experiment 21. July 14. At 1.10 P.M. a fine deälated *integra* female was placed in a nest with 19 *subsericea* workers and many nude worker pupæ, all taken from a medium-sized wild nest. She was at once pinioned by six of the workers and kept in a corner for some time. At 5.15 P.M. she was found dead. None of the *subsericea* workers had been injured.

Experiment 22. July 11, 12 M., an *integra* female was placed in a nest containing 10 large *subsericea* workers with two males, a number of larvæ and some nude pupæ taken from an old mound nest. She was at once attacked and pulled about the nest by her legs and antennæ. She made no attempt to retaliate, but remained perfectly passive, while making rapid and apparently conciliatory movements with her antennæ. The movements were very much like those of the female *consocians* on entering an *incerta* nest and meeting one of the workers. The workers finally succeeded in dragging her out into the light chamber, where she was killed and abandoned by 2 P.M.

Experiment 23. July 23, 8 A.M., a fine female *integra* was placed in a nest with 16 *subsericea* workers of different sizes and many naked pupæ from a rather large colony. She was soon seized by her legs and antennæ and dragged about the nest. She submitted with great docility, and whenever her antennæ were free kept them in constant and rapid motion, as if begging for more merciful treatment. There was so little excitement on the part of the *subsericea* not engaged in maltreating the female that they did not even remove their pupæ. At 1 P.M. the female was found dead.

Experiment 24. July 4, 10 A. M., a female *integra* was placed in a nest with three very small *subsericea* workers, 25 worker cocoons and a few larvæ. The workers attacked the female very gingerly and soon released her. They finally settled down with their brood in one corner of the nest. The female kept hanging about them. These conditions were maintained till July 9, when the female was found to have taken up her station about an inch away from the corner occupied by the *subsericea* and their brood. She had secured five small larvæ and was guarding them carefully. Whenever light was admitted into the nest she carried them away and tried to conceal them. Later in the day both the female and the workers were snuggling together in a corner. From July 10-13 these conditions remained unchanged: the female had been definitively adopted by the workers. July 14, one small callow *subsericea* had hatched during the night and another during the afternoon. On the following day (July 15) three more callows appeared and by 8 A.M. there were in all 10 workers. The illumination of the two chambers of the nest was reversed. There was no movement of the ants during the morning, as the light was rather subdued. At 12 M. the nest was placed near a window. One of the three original workers entered the dark chamber but soon returned and began to pull the female by the mandible and then by the fore leg, whereupon she again ran into the dark chamber, returned and dragged the queen into it. This demonstrated the complete adoption of the female. During the remainder of the month the worker cocoons slowly hatched: by July 18 there were 12 *subsericea* workers, by the 23d, 14, by the 25th, 18, and by Aug. 1, 23. At the present writing (Oct. 12) the queen and her colony of small workers are in excellent condition and, although they occupy only a small portion of the nest are always together. The queen is fed and cleaned by the workers as if she were their own mother.

One matter that is clear from these experiments is the docile and passive behavior of the female and its resemblance to the behavior of *F. consocians* under similar conditions. Such behavior is certainly significant in an ant like *integra* whose workers are so aggressively pugnacious. The last experiment was probably more successful than the others because it was performed with a very few small and timid *subsericea* workers, that is, with just such workers as the female *integra* probably selects in the wild state as nurses for her brood. The experiment at least lends plausibility to the view that the female *integra*, not withstanding her robust stature, is nevertheless, like *consocians*, a temporary parasite. It should be possible to test the truth of this statement by a careful examination of very small *subsericea* nests in localities where *F. integra* abounds.

5. **Formica exsectoides** *Forel.*

The geographical range of *F. exsectoides* seems to be coextensive with that of the true *F. integra*, and, like that subspecies, it has a variety (*opaciventris* Emery) in Colorado. The range, however, has not been accurately determined except in the Eastern States, where it is known to extend along the hills and mountains of the Appalachian system from Maine to North Carolina. Although I have never been able to find *exsectoides* in Illinois or eastern Wisconsin, Father Muckermann, S. J., has taken it in the southwestern corner of the latter State in the vicinity of Prairie du Chien. But Father Muckermann's account shows that the Wisconsin form must be very distinct ethologically. He says that its nests in his neighborhood "sometimes resemble heaps of dirt dumped out at random. Besides they consist for the most part of earth, although the latter is often mixed with vegetable remains. . . The nest entrances are distributed without any apparent order. At any rate, they are not located merely at the base and about the periphery. . . *Formica exsectoides* is one of the ants most frequently met with in this region, and often their colonies consist also of ten and more nests."[1] Parts of this description differ greatly from McCook's account of the nests of the Pennsylvania *exsectoides*, which are regular conical mounds with their entrances arranged in rows around the base. Their size must be much greater than that of the nests described by Muckermann. But *exsectoides* exhibits still another variation in the form of its nests. All of these structures which I have seen near the

---

[1] The Structure of the Nests of Some North American Species of Formica. Psyche, June, 1902, p. 357.

Atlantic seaboard, as for example in the Ramapo Mountains, on Staten Island, in the Litchfield Hills of Connecticut, and in the pine and beech woods near Woods Holl, Massachusetts, are dome-shaped and do not taper to a blunt point above like those figured by McCook. They are often very low, rarely attaining a height of a foot or 18 inches, and are usually surrounded by a broad circle of grass at the base, which may be 3 or 4 feet in diameter. (Pls. XII.–XIV.). The entrances, however, are nearly all aggregated in a broad belt around the base. The average mounds studied by McCook were 2½ to 3 feet high, and he mentions nests 12 and 15 feet across the top, and one, the largest observed, 24 feet across the top, 58 feet around the base, and about 42 inches high. On Staten Island there are about a dozen of the nests in a colony, but in Connecticut and Massachusetts I have found them singly and often at long intervals. All of these facts indicate that the species is in a decidedly more depauperate condition in these different regions than near Hollidaysburg, where its nesting habits were studied by McCook. This author mentions colonies of these ants of as many as 1800 mounds, and he describes the process by which new hills are produced by a kind of nidamental budding or proliferation. After the marriage flight "some of the fruitful females, it is known, are seized by the workers upon the mounds and others upon the neighboring grass-stalks and weeds, and are thence forced into the hill. But there must be some who drop upon secluded spots, and unobserved begin measures for the establishment of new families, according to their instinct. These families eventually erect independent hills, which in turn become the mother hills of new hill-clusters. Thus ant colonies, like some groves and forests, grow from the parent stock by shoots."

This observation, together with others recorded in McCook's paper, indicates that new nests of *exsectoides* may be formed like those of *F. rufa* in Europe. In a former paper I have given my reasons for believing that the *exsectoides* colony is originally started by temporary parasitism on *F. subsericea*. Schmitt, Forel and myself have all found small mixed colonies of these two species under circumstances which, in the light of my observations on *F. consocians*, certainly justify such an inference. Experiments with artifically deälated females of *exsectoides* introduced into small colonies of *subsericea* workers gave practically the same results as those above recorded for *F. integra*. In all except one of seven experiments the results were negative, but they revealed, nevertheless, some of the inquilinous instincts of the *exsectoides* female. Only three of the experiments are here recorded.

Experiment 25. July 13. A winged female *exsectoides* that was being dragged about in the galleries of a wild colony of *F. sanguinea* var. *subintegra* by the *subsericea* slaves was released and at 3 P. M. deälated and introduced into the dark chamber of a nest containing 12 *subsericea* workers and many cocoons. As soon as her presence was perceived the workers snatched up their cocoons and fled with great precipitation into the light chamber. Soon the female found the opening and also escaped into the same chamber. The *subsericea* approached her from time to time but seemed to be afraid to attack her. At such times she crouched, folded her antennæ, and rapidly titillated the workers' heads with their tips. Sometimes she begged for food, but her appeals were ignored. Her whole behavior could only be described as humble and supplicating, and recalled very vividly the behavior of the *F. consocians* female in the presence of alien *incerta* workers. Soon, however, the *subsericea* began to seize the tips of her antennæ and then a leg, pulling mildly and spasmodically at first, but growing bolder, apparently on becoming aware of the inoffensive attitude of the female. At 5.30 P. M. she was released and at once began to lick the mouth-parts of one of the workers in a most affectionate manner while rapidly vibrating her antennæ. July 14, 6.30 A. M., the female was found dying in the light chamber, with a hole gnawed in her gaster. The workers had devoured her viscera during the night. Her legs and antennæ, however, were still intact.

Experiment 26. July 16. 3.20 P. M. A fine active *exsectoides* female was placed in a nest with 14 medium-sized *subsericea* workers and many nude pupæ. She was at once attacked and dragged about by her appendages. Without resisting, she folded her appendages close to her body and allowed herself to be pulled about passively, making slow appealing movements with her antennæ. At 4.30 P. M. she was still being maltreated by a number of the workers, but made no attempt to retaliate, though she bit my finger when I tried to remove her from the nest. The workers endeavored to force their mandibles into her body, but they slipped from her polished integument. Then they tried to saw off her legs at their coxal articulations. By 7.20 P. M. they had amputated one leg. July 17, 7.30 A. M. The female was still alive, but had been shorn of both antennæ and several legs. Two workers were busily gnawing at her hips. The experiment was discontinued.

Experiment 27. July 23, 1 P. M. A fine female *exsectoides* was placed in a nest with 7 *subsericea* workers and 14 nude worker pupæ nearly ready to hatch. She was not at once attacked by the workers, who approached her rather timidly, opened their mandibles a little in a menacing attitude and then turned away. She showed no signs of fear but stretched forth her long antennæ and caressed each worker when it approached. From 2.50 to 5 P. M. she was being pulled about by one of her antennæ or legs. July 24, 8 A. M., the female was snuggling quietly in a corner with the workers and their brood. No signs of hostility were witnessed during the day. From that day to the present writing (Sept. 5) the female has lived in perfect amity with the seven original workers and ten others that had hatched soon after her adoption. She is fed by the workers, and, though the tiny colony occupies but little space in the nest, is always found in their company.

6. **Formica sanguinea rubicunda** *Emery.*

Two forms of the sanguinary ant are pretty generally distributed over the northern portion of the United States: *Formica sanguinea rubicunda* Emery and its variety *subintegra* Emery, the former with a black, the latter with a brown or even yellowish, gaster. In most localities, so far as I have been able to observe, the var. *subintegra* is the more common and often the only form represented. This is certainly true of the region about New York where I have hitherto found only *subintegra.* At Colebrook, Conn., where both occur in the same localities, there is also another much rarer form, which agrees very closely with Forel's description of the subspecies *aserva* and with types of this form which he kindly sent me some years ago. I have used females of all three of these forms in my experiments, but the results obtained with *subintegra* and *aserva* leave much to be desired.

During the last days of June I found a large army of *rubicunda* in the act of plundering a nest of *F. subsericea.* I followed the cocoon-laden workers a distance of about seventy feet to their nest, which was on a sunny slope under two large stones. On removing these many fine female pupæ were found in the galleries and were carefully transferred to an artificial nest, where they soon began to hatch. The young females were abundantly fed with sugar, houseflies, etc., and were not used for the experiments till fully mature. In all twenty-one experiments were performed. These may be divided into three groups: nine were failures, two were partially and the remaining ten completely successful. Two thirds of these experiments are given below for the sake of emphasizing the typical reactions of the female *rubicunda.* It is most improbable that this insect would respond to an artificial environment with such a regular series of reactions unless these are the very ones she habitually displays while establishing her colonies in a state of nature.

Experiment 28. July 13. At 2.15 P.M. a *rubicunda* female was introduced to 17 *subsericea* workers with worker pupæ taken from a wild colony of average size. They at once fell upon her, four and six at a time, and succeeded in killing her by 3 P.M.

Experiment 29. July 14, 7.30 A. M. a female *rubicunda* was placed with 12 *subsericea* workers and about 150 worker cocoons. She was immediately attacked by several of the workers and dragged about the nest on her back. Often the *subsericea* were so excited that they kept tugging at a leg or antenna of one of their own sisters that happened to be pulling one of the female's legs. The female was singularly passive, but was finally so thoroughly aroused by the pulling and tweaking that she killed three of the workers by 12 M. In these struggles she lost one antenna and died at 2 P.M.

Experiment 30. July 11. At 11 A.M. a *rubicunda* female was placed in a nest containing 30 large and medium-sized *subsericea* workers with naked worker pupæ and semipupæ from a rather large mound nest. She was at once seized by eight workers and pulled about by all her legs and antennæ. She resented this treatment, threw off her assailants and by 11.30 A.M. had killed nine of them. She herself, however, succumbed a little after 12 M.

Experiment 31. July 23, 11 A.M., a fine female *rubicunda*, that lost her wings while she was being taken out of her own nest, was placed with 12 large *subsericea* workers, two males, and a number of larvæ and nude worker pupæ taken from a large mound nest evidently of several years' standing. She ran about in dismay, trying to avoid the workers, but at 11.10 A.M. her legs and antennæ were pinioned by two and then by four workers. She shook them off adroitly but was soon held fast by three others. This so thoroughly aroused her that she killed them by biting them one by one through the head or thorax. Almost at once, however, two workers fell upon her, stretched her legs and sprayed their articular membranes with formic acid till she succumbed at 11.30. She had been overcome in a surprisingly short time.

These experiments show very conclusively that *rubicunda* is received with great hostility and may be quickly dispatched by even a small number of *subsericea* workers. It is certain that she would stand no chance of survival if she attempted to enter a large colony of these ants. The experiments also show that the female resents the treatment she receives, but this is more clearly manifested in the following cases:

Experiment 32. July 7. 10 A.M. A female *rubicunda* was introduced into a nest containing 12 large *subsericea* workers with a number of worker cocoons. As soon as she was perceived, some of the workers snatched up their cocoons and fled to the light chamber, just as they are in the habit of doing when their nests are attacked by *rubicunda* workers; while others fell upon her and began to tug at her legs and antennæ. This she endured patiently for some minutes, but finally succeeded in shaking off her assailants and, thoroughly aroused, began to prance back and forth in the chamber, pouncing on any worker that came within her reach. She killed two of them in rapid succession and then at once began to collect the cocoons and tuck them away in one of the corners of the nest. She collected 18 of them, mounted the pile, and with wide open mandibles, stood guard over them. The *subsericea* hurriedly carried the remainder of the cocoons into the light chamber and plugged up the entrance between the chambers with some pellets of earth. July 8 matters remained *in statu quo* during the entire day. The female never left the brood she had appropriated and the *subsericea* made no attempt to recover it. During the night, however, there must have been such an attempt, as the female was found dead at 8 A.M., July 9, and the workers had carried the 18 cocoons into the light chamber and had placed them with the others.

Experiment 33. July 10, 9 P.M., a female *rubicunda* was placed in a nest with 8 medium-sized *subsericea* workers and about 100 larvæ and pupæ. She was attacked, but killed 2 of the workers and then ran into the light chamber with a single small larva, which she continued to hold in her mandibles till I retired at 11 o'clock. At 6 A.M. on the following morning I found that she had killed all the workers during the night and had carried about two thirds of the brood into a corner of the dark chamber. At 6.30 A.M. a callow worker had hatched from one of the nude pupæ. The female remained with the brood during the day but was very sluggish. July 12, 6.30 A.M. another callow had hatched during the night. The female had left the brood and was clinging to the wet sponge. She seemed to be very weak. At 4 P. M. she was dead.

In experiments 32 and 33 the *rubicunda* female was interrupted in the display of her instincts by death, caused without doubt by injuries received while killing off the *subsericea* workers. I believe that such deaths are due to spraying of the distended articular membranes of the limbs with formic acid. Probably at these points the acid is absorbed, and, thus admitted in small quantities into the blood, causes a slow paralysis which, as in the last experiment, overtakes the female in the midst of her catenary reflexes, or instincts. At any rate, in these and most other cases where the females succumb after struggling with alien workers, death is certainly not due to wounds or mutilation. In the following experiments the females, either because of their exceptional strength and agility or the weakness of the *subsericea* with whom they were confined, survived and were able to display the whole series of their colony-establishing instincts.

Experiment 34. July 8, 9 A.M. A *rubicunda* female was placed in a nest containing 33 *subsericea* workers, small and large, 150 cocoons, and a few larvæ. The workers at once seized their cocoons and fled into the light chamber. One or two of them attacked the female, but she shook them off and killed one of them. In the meantime some of the workers kept stealing into the dark chamber for the purpose of securing cocoons and carried them to the remotest corner of the light chamber. As the morning wore away the female gradually became more and more excited. By 1 P.M. she had killed five more workers and was busy carrying the cocoons back from the illuminated into the dark chamber, where she had already stored most of them in a corner. In a few minutes she had secured all the cocoons in the light chamber, 36 in number. She interrupted this task twice, each time for the purpose of killing a worker that came within her reach. Finally she retired to the dark chamber and began to collect the cocoons into a more compact pile. Two of the workers persisted in stealing in and hurrying back with cocoons taken from the edge of the pile. The female soon perceived this, however, and dispatched both of them. The whole performance resembled a dulotic expedition in miniature, carried out by a single virgin female instead of by an army of *rubicunda* workers. In killing the *subsericea* workers, she was quite as ruthless as the workers of her own species but much surer on account of her larger size and greater strength. She exhibited very beautifully what may be called the "prancing" movement, so characteristic of the females in this stage of their activities. She moved in a jerky fashion, taking a few steps in one direction, then turning the body and taking a few steps more. July 9, 8 A.M., only two of the workers survived. They had regained possession of 30 of their cocoons, however, and were guarding them in a remote corner of the light chamber while the female was watching over the great bulk of the brood in a corner of the dark chamber. By 10.30 she had entered the light chamber, recaptured all but 6 of the cocoons, carried them into the dark chamber and placed them on her pile. The two workers were wandering about in a state of "abulic dejection." At 11.30 one of them was seen to enter the dark chamber and approach the female, but the latter opened her mandibles and the worker fled. The female had stacked her cocoons in a compact heap and was bent on defending them. Apparently she had not forgotten the 6 cocoons still remaining in the light chamber. At any rate, she secured 4 of them by 12 M. She took up her position on the pile of cocoons, and whenever light was admitted into the dark chamber, opened her mandibles and went to prancing about as if looking for an enemy. By 1.15 P.M. she had secured one of the two remaining cocoons in the light chamber. July 10, 6 A.M. In the night the female killed the two remaining workers and took their last cocoon. Throughout the day she kept closely to the brood, prancing whenever the light was admitted into the chamber and fiercely seizing a straw or my finger whenever either was held near her. She seemed to display a much greater interest in the pupæ than in the larvæ. July 11 to 15 she remained *in statu quo*. Whenever the nest was uncovered she hastily took up a cocoon and tried to conceal it. July 16, 7 A.M., 5 callow workers had hatched during the night. One larva had been partially eaten by the female. At 1.40 she was surprised in the act of opening a cocoon. She used her fore and middle feet to hold the cocoon while she tore a large elliptical hole with her mandibles in the portion of its wall overlying the con ave ventral surface of the pupa. Through this hole the worker was later drawn after it had thrust out its antennæ and legs. Whenever the nest was uncovered throughout this and the following of the first days, the female could nearly always be detected in the act of either opening a cocoon or removing the pupal envelope from a callow just released. By the afternoon of July 16 some of the callows began to assist the female in releasing their sister workers. The number of callows now began to increase rapidly. On the morning of July 17, there were 19 altogether, by 5 P.M. 24, by 7.30 A.M., July 18, 30, and by 7.30 A.M., July 19, 50. On the following days the numbers ran thus: July 20 about 60; July 21 about 75; July 22 about 100; July 23 and 24 about 130. This completed the callow brood, as some of the cocoons failed to hatch. The female took the greatest interest in her black family and they bestowed on her every attention. Soon after they had begun to feed and clean her another marked change supervened in her instincts. Instead of defending herself and brood when the nest was uncovered she slunk away, or at any rate attempted to conceal herself among the mass of workers. She had become highly photophobic and behaved exactly like the old queens, that invariably make for the galleries whenever the nest is disturbed or illuminated. This experiment was concluded and the ants liberated in the garden on July 26, as I had to leave Colebrook for New York on the following day.

Experiment 35. July 9, 10 A.M. Placed a *rubicunda* female in a nest containing only 4 *subsericea* workers and about 200 worker and two female cocoons. The workers at once grabbed cocoons and fled into the light chamber. The female ran about the dark chamber and escaped into the light chamber, but at once returned, forcing her way through the entrance, which was much obstructed with earth, and began to collect and pile up the cocoons in a corner. The workers kept returning and stealthily snatching cocoons from the edge of her pile and hurrying away with them into the light chamber. She perceived one of these returning workers, pounced on her and killed her with a blow of her mandibles. This first murder thoroughly aroused her and she began to prance to and fro. Another worker returned, but before she could be grabbed had seized one of the female's antennæ. The two ants now began to pull in opposite directions, while the remaining workers made haste to carry the cocoons into the light chamber. At 11.30 the female had killed the worker and freed herself without losing her funiculus and was in the act of killing a third worker. She at once began to bring the cocoons back to the corner in the dark chamber. She removed 80 of them in 30 minutes, that is at an average rate of $2\frac{2}{3}$ per minute. Only four cocoons were overlooked and left in the light chamber. Then she returned to the dark corner and began to stack up the cocoons. Meanwhile the single surviving worker ran about in great trepidation, fleeing whenever the female approached her, and endeavoring to escape from the nest without making any attempt to carry away the cocoons. Whenever the dark chamber was uncovered the female at once tried to secrete her cocoons in some other part of the nest, thus showing a clear sense of proprietorship. By 2 P.M. she had also secured three of the four cocoons remaining in the light chamber. July 10 to 11. The female had built all the cocoons into a more compact pile and was resting on them with half-open jaws ready to attack any comer. July 12. During the night a callow worker and callow female *subsericea* hatched. Two more callow workers and several naked pupæ from a wild colony were placed in the light chamber. These were found by the female and carefully removed to her pile. She paid no attention to the *subsericea* female. The callows joined the female *rubicunda* in caring for the pupæ. At 5 P.M. one of the older callows was seen in the act of freeing a young callow from its cocoon. July 14 another callow hatched. The female *rubicunda* was very solicitous about the cocoons whenever the dark chamber was uncovered. There were now one female and five worker *subsericea*. This female also at times helped in stacking up the cocoons. July 15, 7 A.M. There were 8 workers and one callow in the act of hatching and by evening others had been divested of their pupal envelopes. July 16, 7 A.M. there were 25 workers. At 2.30 the *rubicunda* female was surprised in the act of licking a callow and carrying it a short distance as if to hide it. By 4.30 P.M. there were 34 callows. At 7 P.M. the female was seen to open a cocoon. She held it firmly in her two fore feet while she made a rent in the center of its ventral surface with her mandibles. July 17, 7.30 A.M. there were 45 workers altogether, most of them still very callow. The female *rubicunda* spent most of her time opening cocoons and freeing the callows from their pupal envelopes. By 5 P.M. there were 55 workers and by the following morning (July 18, 7.30 A.M.) 63 were counted. The number rose to 80 by 7.30 A.M. July 19. The female still tried to hide her cocoons whenever the nest was uncovered. Many of the workers were busy assisting the callows to hatch. July 20, 8 A.M., there were about 100 workers in the nest and several were hatching. A large number had matured. July 21 and 22 the female *rubicunda* no longer attended to the brood or hurried away with a cocoon when the nest was opened, but slunk away and tried to conceal herself in the mass of workers, behaving exactly like the old females one finds in wild nests. By July 22 more than 125 mostly mature workers were counted. The *subsericea* female had lost her wings during the night. By evening the number of workers was nearly 150 and during the following 4 days (July 23 to 26) it rose to 175 approximately. Both females were living peacefully side by side. The colony was released in the garden at 6 P.M., July 26.

Experiment 36. July 14, 5.30 P.M. A female *rubicunda*, mature but with small, shrivelled wings, was placed in a nest with 11 *subsericea* workers of medium and large size, a few worker and 3 female cocoons and a few larvæ, taken from a rather small colony. The female was attacked and almost at once succeeded in killing 3 workers (5.55 P.M.) At 6 P.M. she disabled one, and killed another a minute later. She dodged whenever she encountered a worker. July 15, 7 A.M. The female was loitering in a corner far from the brood and the workers. By 2.30 P.M. one of the female *subsericea* had hatched. During the whole day the *rubicunda* rested quietly on the sponge at some distance from the workers, that huddled in a corner with their brood. July 16, 7 A.M. one more worker was killed by the female during the night, so that only 5, the largest individuals, remained alive. The female was resting near the brood. By 12 M. only 4 workers remained and the female had driven the workers from their corner and was in possession of 19 cocoons. Another female *subsericea* had hatched. The 4 workers and 2 *subsericea* females had taken refuge with a few cocoons in a lighted corner of the chamber. They seemed to be possessed with the desire to get as far as possible from the *rubicunda* female. This female had become very alert and was much interested in the cocoons. At 2.40 P.M. when the nest was uncovered she tried to hide her cocoons, of which she now had only 4, all the others having been recovered by the *subsericea* and carried to the diagonally opposite corner, which was strongly illuminated. Fear of the female *rubicunda* appeared to be stronger than the instinct which compels these ants to keep their brood in the dark. The female began to run about wildly as if suddenly filled with a craving to get cocoons. She pranced around with half-open mandibles ready to attack any worker. She flew at a worker that was coming up to steal a cocoon and pulled the mandibles of one of the callow *subsericea* females. She killed one worker, thus reducing the number to three. Although these were the largest individuals, they fled in great trepidation whenever she approached. At 4.30 P.M. the female *rubicunda* had collected 11 cocoons and was guarding them with raised head and open mandibles. By 6.50 P.M. she had secured 23, including the unhatched female cocoon. She was no longer molested by the 3 workers. These were trying to escape by gnawing at the towelling in the light corner. July 17, 7.30 A.M. During the night the workers had recovered some of their cocoons, leaving only 17 worker cocoons and a larva with the female *rubicunda*. July 18, 7 A.M. She had regained all her pupæ during the night. The 3 workers were still alive. The female was very sluggish. At 8.30 the *subsericea* workers were opening the third and last female pupa. By 12 M. the female *rubicunda* had recovered all the cocoons and was guarding them in company with the 3 callow *subsericea* females.

Another worker had been killed. The remaining 2 were wandering about aimlessly and not endeavoring to recover their cocoons. One of them had lost an antenna. At 1.30 P. M. they tried to associate themselves with the *rubicunda* and *subsericea* females. The latter were a link between the two inimical factions represented by the workers and *rubicunda*. July 19, 7.30 A. M. the colony was *in statu quo* except that one of the *subsericea* females was dying. July 20, 7.30 A. M. During the night the *rubicunda* had killed one of the workers and injured another. She was now in full possession of the brood and two surviving *subsericea* females. July 21 the experiment was discontinued.

Experiment 37. July 14, 2. P. M. A vigorous and active *rubicunda* female was placed in a nest with 9 *subsericea* workers and about 150 worker cocoons. By 2.17 P. M. she had killed 6 workers and was rushing wildly about the nest, apparently more in fear than in anger. Two of the three remaining workers were callows. By 5.20 P. M. she had carried nearly all of the cocoons to a corner of the nest and was standing guard over them with open mandibles. At 6 P. M. one of the callows associated herself with the female. July 15, 7 A.M. the other callow had joined the female, who had transferred all the cocoons to another corner of the nest. The single mature worker was lurking in the diagonally opposite corner. The dead *subsericea* which were scattered about the nest yesterday had all been collected (by the female?) and placed in a pile near the cocoons. Whenever the nest was uncovered the female endeavored to conceal the brood. July 16, 8 A. M., 3 callows had hatched in the night. The mature worker was with the brood, but ran away and hid when the nest was uncovered. The female was very alert and showed great solicitude for the brood. At 2.20 P. M. the single adult worker kept away from the brood and tried to escape from the nest by gnawing at the towelling. July 17, 7.30 A. M., this worker had joined the callows and all the ants were living peacefully together. Later in the morning the total number of workers had risen to 12. At noon the single mature worker deserted the brood and went to stay in the light chamber, the entrance to which had been closed on the previous day. July 18, 8 A.M., there were 27 *subsericea* workers altogether. The single mature worker had again joined the colony during the night and mingled with the callows. Henceforth she became a permanent member of the colony. The number of workers increased to 36 by noon. July 19, 7.30 A. M., there were 51 *subsericea*. The female was very timid when the nest was uncovered. Although she seemed to be much interested in the callows she was not seen to care for the cocoons after the callows had begun to aid one another in hatching. The number of *subsericea* increased as follows: July 20 there were about 60; July 21 about 80; July 22 about 90; July 23 more than 100. At 12 M. on the date last mentioned the colony was given 150 worker cocoons of *F. rufa integra*. They at once seized them and began to carry them to the pile of unhatched cocoons of their own species. July 24, 8 A. M., there were about 125 *subsericea* in the nest. They were carefully hoarding the *integra* cocoons mingled with a few remaining cocoons of their own species. July 25, 7.30 A. M., the *subsericea* took a few of the *integra* pupæ out of their cocoons, killed them and threw them on the refuse heap. Two callow *integra* were walking about the nest. July 26 both of these callows had been killed. The nest was transported to New York and not examined till August 6, when nearly all the *integra* had hatched and most of them had matured. They have since formed a part of this triple mixed colony and are living in perfect amity with the *rubicunda* female and the *subsericea* workers (Sept. 12).

Experiment 38. July 15, 7.30 A.M., a female *rubicunda* was placed in a nest containing 11 medium-sized *subsericea* workers with more than 100 naked worker pupæ and semipupæ from a rather small colony found under a stone. The female was not molested during the day, but at 6 P.M. was quietly resting at some distance from the workers and their brood. July 16, 7 A.M., the female was still resting at the edge of the brood. Two workers had been killed during the night. While the nest was under observation a worker approached the female and seized her by the antenna. She at once curled her body about the worker and killed her. The morning, like the preceding night, was cold, so that the ants were very sluggish. At 12 M. the female seemed to be seeking adoption among the *subsericea*. Whenever the nest was uncovered she was found hanging about the workers and their brood. The workers seemed to be on the defensive. At 6.50 P.M. the female suddenly took possession of the pile of pupæ in the corner of the nest and was prancing about. This alert and excited behavior was extraordinary after her lethargy during the whole day. Whenever a worker entered the corner she was driven away or killed. Seven of the workers were killed between 6 and 6.50 P.M. The survivors fled to the light end of the chamber with some of their pupæ and at 7.20 P.M. were dragging pellets of earth to the corner and trying to barricade themselves from the female. July 17, 7.30 A.M., the female had killed the remaining 4 workers and had collected all the nude pupæ and semipupæ in a compact pile. At 8.40 the corner in which the female was guarding the brood was brightly lighted and another corner of the chamber was darkened. By 9.45 she had carried all the brood into the dark corner and was guarding them with open mandibles. At 11 A.M. another female *rubicunda* from the same colony was introduced. This female (B) was readily distinguished from the first female (A) in the following observations by her wing stumps. B on approaching A was at first violently attacked, but she was soon recognized and permitted to pass. July 18, 7 A.M., female B seemed to be less attached to the brood than A. One callow had hatched during the night and at 8.45 another appeared and was being licked by female A. By 7.30 A.M. female B had come to take as much interest in the brood as A. When the nest was uncovered both females hastened to conceal the pupæ and semipupæ, and when a straw or the finger was brought near the brood both females thrust their mandibles into it. The callows were beginning to assist the females in freeing the young from their pupal envelopes. July 19, 7.30 A.M., the *rubicunda* sisters behaved as on the preceding day and carried the pupæ to the same dark spot when their corner was exposed to the light. July 20, 7.30, 2 callows had hatched during the night and two appeared on the following day, July 21. Two more hatched July 23, but no others had appeared by July 26, when the experiment was discontinued.

Experiment 39. July 18, 8 A.M., a *rubicunda* female was placed in the dark chamber of a nest with 12 medium-sized *subsericea* workers and about 150 nude worker pupæ and semipupæ. The adjoining chamber was then opened and the illumination reversed. The workers began to move their brood into the other (now darkened) chamber, and succeeded in getting about 50 of their pupæ through the entrance when the female became suddenly much interested in the brood. She killed 2 workers in quick succession and began to collect the pupæ in the light (previously dark) chamber and tried to conceal them, at first in the entrance and then in one of the corners which I darkened for her. The pupæ in this chamber were at first much scattered, but the female had collected all of them by 8.40 A. M. Meanwhile one worker kept stealing into the chamber and making off with some of the pupæ into the dark chamber. At 9 A. M. the female caught one of the workers *in flagrante delicto* and nearly killed her with a blow of her mandibles. She released the worker and went to look after the pupæ. Later, on passing, she noticed that the worker was still moving and dispatched her. By 9.10 the female had collected all but 2 of the pupæ, 37 in number, and was carefully guarding them at 12 M. July 19, 7.30 A. M., she was surprised in the act of removing the pupal skin from the limbs of a hatching callow. She was still very alert and pugnacious and during the night had evidently successfully protected the pupæ from all incursions of the *subsericea* workers in the adjoining chamber. Another callow hatched at 4 P. M., July 20. Matters were *in statu quo* except that a third callow had made its appearance during the night. The female was not molested by the *subsericea* workers, that remained in their own chamber after plugging up the entrance with pellets of earth. At 6.30 P. M. the female had 7 callows and by 7.30 A. M. on the following morning an eighth had made its appearance. Matters remained *in statu quo* during the two following days, when the female was released in the garden.

Experiment 40. July 19, 8 A. M. Two *rubicunda* sisters, A and B, distinguished by a difference in size, were placed in a nest containing 6 mature, medium-sized *subsericea* workers, 12 callows two days old but able to run about and carry pupæ, and about 125 nude pupæ, all with pigmented eyes and some of them brown and nearly ready to hatch. The workers at once fled with their brood. Female A began to prance about as soon as her antennæ had explored the fine assortment of pupæ. She went from one worker to another pinching and when necessary killing them. Even the young callows tried to defend themselves and their brood, but were soon (8.15 A. M.) driven to the other end of the nest. A at once began to move the pupæ into a corner. B was less excitable and very listless; she at first tried to escape from the nest by biting at the towelling; then she dug a hole in the earth, and finally took to carrying pellets of earth, dead *subsericea* workers, etc., for short distances in a desultory manner. At last, however, she joined A in defending the pupæ and even tweaked the workers when they ventured into her neighborhood. Both of the females seemed to be very lenient with the callows and seriously injured only 2 of them, while they killed 4 of the mature workers outright. The workers, however, succeeded in recovering about a dozen of their pupæ. Female B now set about collecting the young callows and carrying them to the pile of pupæ, and then began to take the pupæ away from the workers at the farther end of the nest. By 8.30 both females were equally excited and busy and working in unison. The two opposite ends of the chamber were darkened and the middle portion exposed to the light for the purpose of ascertaining whether the females would establish separate nests. 11 A. M. With the exception of the two youngest callows, every *subsericea* in the nest had been killed and their bodies had been placed by the females at one end of the nest, while they had collected all the pupæ and the two young callows in a single pile at the other end. Both females fondled and licked the callows and tried to conceal them and the pupæ whenever the nest was uncovered. By 4 P.M. 4 pupæ had hatched. Whenever one of the callows tried to crawl away from the pile of pupæ, female B would follow her, seize her in her mandibles and bring her back, much as a cat carries her kitten. Both females were equally solicitous about the young. They had even brought back some of the youngest of the dead callows from the opposite end of the nest and had placed them with the pupæ. On the succeeding days the number of callows increased as follows: July 20 there were 13; July 21, 23; July 22, 32; July 23, 36; July 24, 40; July 25, about 50. During all this time the females showed no tendency to establish different colonies by dividing the brood, nor any signs of hostility towards each other. At 6 P.M., July 26, they were set free

Experiment 41. July 23, 1.15 P.M , a *rubicunda* female was introduced into a nest containing 21 medium-sized and large workers of *subsericea* with a number of semipupæ and naked pupæ from a large colony nesting in a mound. She was at once attacked but promptly killed two of the workers, then a third, and then angrily pulled one by the mandibles. By 5.30 P.M. she had killed all but one of the workers and was busily collecting the brood and storing it in a dark corner of the nest. July 24, 8 A.M. The single worker was still alive but wandering dejectedly about far from the female and the brood. Two callows had hatched during the night. July 25, 7.30 A.M. The single worker had been killed during the night and the female was in undisputed possession of the pupæ. A third callow had appeared and by 2.15 P.M. two more had been freed from their pupal envelopes by the female. On the following day (July 26) a sixth callow hatched. The little colony was set free in the garden at 6 P.M.

The above series of successful experiments shows very clearly that the female *rubicunda*, when placed with a small number of *subsericea* workers and their pupæ, displays a chain of instincts that result in her gaining possession of the latter. To all appearances she is quite ready to be amicably adopted by the *subsericea*, but when received with marked hostility, as is probably almost invariably the case, her animosity is very quickly kindled, and she slays the *subsericea* with all possible dispatch, thus manifesting instincts very similar to those of her own workers when engaged in a dulotic raid. Owing to her powerful mandibles and closely knit frame she is always a match for several workers and may kill as many as 21 of these (Experiment 41) in a very short time. Before she has killed them all, however, she becomes much interested in their brood, eagerly collects and secretes it in some favorable corner and guards it with open mandibles till the callows are ready to hatch. These she skilfully divests of their cocoons and pupal envelopes. Their advent in considerable numbers appears to be the signal for another marked change in the instincts of the female. She now becomes very timid, fleeing whenever the nest is disturbed and taking refuge in the darkest and remotest corner of the nest. In this instinct phase the female remains throughout the remainder of her life. The reactions displayed in the foregoing experiments are, moreover, so definite, uniform and purposeful even in artificial nests that one can hardly doubt that they are similarly manifested in a state of nature. It is evident that, especially in timid incipient wild colonies of *F. subsericea*, the females may meet with less opposition and therefore with greater and more immediate success. Still the fact that *rubicunda* is a local ant and by no means one of our most abundant species shows that the successful establishment of colonies in a state of nature must be attended with considerable difficulties. The search of the *rubicunda* female for weak or incipient *subsericea* colonies, even in regions where the latter ant is very abundant, must often be vain or illusory. This is tantamount to saying that the element of chance must enter very largely into the life of the *rubicunda* queen, just as it does into the lives of most parasitic animals.

7. **Formica sanguinea rubicunda** var. **subintegra** *Emery.*

The females of this form are much smaller than those of *rubicunda* proper. A few of them were taken July 10 from a flourishing colony containing many *subsericea* slaves, and were used for experiments like those performed with *rubicunda.* They gave negative results, however, for in every case the female was killed by the workers before she could show an interest in the cocoons or try to collect them. It is, of course, quite possible that these small females may be less pugnacious than those of the pure *rubicunda* and rely on amicable adoption by the workers of incipient *subsericea* colonies rather than on killing the workers and appropriating the young. The following may serve as an example of the experiments performed with *subintegra.*

Experiment 42. July 17. At 11.45 P.M. an artificially deälated female *subintegra* was placed in a nest with 7 *subsericea* workers and 10 pupæ (5 nude and 5 in cocoons). One of the workers at once seized her by an antenna, but the others at first sought to avoid her. She grabbed the irate worker by a leg and tried to amputate it. While the two ants were in this predicament, a worker came up and began to lick the female's head and mandibles effusively. Then another worker came up and did the same, but soon departed. The female tried to cut off the gaster of the worker pulling at her antenna. Meanwhile another worker approached and licked the female's head. At 1.05 P.M. she killed the worker that was holding her, and succeeded in extricating her antennal funicle. She was very alert and examined all parts of the nest very carefully. The workers, annoyed and frightened by the female, tried to conceal their brood in the manger. While running about the nest the female felt into the manger and was at once attacked by 3 workers simultaneously. She managed to shake off two of them and to catch the third by the hind leg. She dragged this worker about, stopping from time to time to curl her body as if to spray her victim with formic acid. The worker finally escaped. The others seemed to be much afraid of the female and fled whenever she approached. She did not seem to be at all interested either in them or their brood, but settled down on a lump of sugar and began to lick it eagerly. July 18, 7 A.M., the female was lying dead but unmutilated some distance from the workers and brood. Six of the workers were still living.

This unsatisfactory experiment proves little more than that the *subintegra*, like the *rubicunda* females, resent the attacks of *subsericea* workers. It throws no light on the method of colony formation unless, perhaps, the caressing behavior of the workers in the early part of the experiment may be taken to indicate amicable adoption of these females by feeble colonies of *subsericea*.

8. **Formica sanguinea aserva** *Forel.*

Of what I take to be this ant I have found only two colonies at Colebrook, Connecticut. These were about a mile apart and each was in a large prostrate log. The galleries besides permeating the wood extended into the soil, in one case to a distance of about 8 ft., where they terminated in another nest under a large stone. Although there were several hundred large workers in each of these colonies I failed to find more than 5 or 6 *subsericea* slaves in either of them. Exactly the same condition was observed in one of these colonies during the summer of 1904. Neither colony was very large, not nearly as large as the *rubicunda* colony from which the females were taken for the experiments above recorded. That one of them was still in its prime was shown by the great number of female cocoons which I took from it during July. These were kept in an artificial nest with several workers till they had hatched and matured. The workers, and especially the females, have the head and thorax dark brown instead of blood red as in the common forms of *sanguinea*. In many of the females the head is almost or quite black. At first sight the ant resembles *F. pergandei* Emery but is much more robust, the head is broader and the petiole has an acute instead of a blunt border. The workers vary much in size and the females are smaller than those of the typical *rubicunda*, but somewhat larger than those of *subintegra*. *F. aserva* seems to be a distinct and constant form and to be widely distributed in New England. Mrs. Annie Trumbull Slosson has recently sent me a couple of dealated females taken on the summit of Mount Washington and another from Franconia, New Hampshire.

Four experiments with fine mature females of this subspecies placed with a few workers of *subsericea* all gave unsatisfactory results, like the following:

Experiment 43. July 21, 6 P.M., a female *aserva* was placed in a nest containing 11 small *subsericea* workers and some nude pupæ taken from a small colony under a stone. The female was at once attacked by a worker but curled her body and tried to kill her assailant. At first she could not free herself and soon had two more workers pulling at a leg and antenna. She finally succeeded in extricating her antenna, but by 6.30 had lost both hind tibiæ and was being pulled about by 3 workers. At 6.45 she killed one worker and ran about with another dead one dangling from her antenna. By 7 P.M. she had cast off this encumbrance and was resting on the sponge. As her hind legs had been seriously injured she was removed from the nest and the experiment was discontinued. In another similar experiment the *aserva* female was promptly dispatched by the *subsericea* workers after she had killed two of their number.

These cases show that the female *aserva*, like the female *rubicunda* and *subintegra*, is by no means a patient inquiline like *consocians*, but when severely tweaked is always ready to defend herself with her mandibles and formic acid batteries. Further inferences in regard to the founding of colonies by this form can hardly be drawn from the above experiments.

9. **Polyergus rufescens lucidus** *Mayr.*

On returning to my home at Bronxville, New York, early in August, 1905, I at once visited a large colony of *Polyergus lucidus* with *F. schaufussi* slaves, which I had had under observation during the summers of 1903 and 1904, in the hope of finding a number of virgin females to use for my experiments. I was not to be disappointed, for the nest contained a lot of females and males, fully mature and ready for their nuptial flight. Thirty of the females were secured and confined in an artificial nest with several of their slaves. During the month of August I tried 12 experiments with as many of these females, but in no instance could I observe an adoption of these insects by strange *schaufussi* workers. The results are varied and conflicting, but as they are suggestive and can be briefly reported, I transcribe several of them from my note-book

Experiment 44. Aug. 6, 5.30 P.M., a female *Polyergus lucidus* was placed in a nest with 15 *Formica schaufussi* workers, small and medium-sized, taken from an average colony, together with 100 cocoons and 26 larvæ. After running about the nest for some time she was seized by a worker, which she killed by running her mandibles through its head. Then further struggles ensued between the two species and resulted in the crippling of two of the workers. By 9 P.M., however, the female showed signs of having been injured. Though still able to walk, she was found from time to time lying on her back with sprawling legs. Aug. 7, 6 A.M., there were 7 maimed workers in the nest, showing that the female had had many struggles during the night. She was lying on her back and appeared to be very weak. As she showed no signs of recovering, the experiment was discontinued.

Experiment 45. Aug. 7, 12 M. Into the nest used for the preceding experiment and still containing 8 *schaufussi* workers, another *Polyergus* female was introduced. At 6 P.M. she was still in excellent condition though she had killed 3 of the workers. Aug. 8, 7 A.M. Another worker had been killed during the night. The female seemed to have no inclination to associate with the survivors and showed no interest in their brood, but rested quietly on the sponge. Aug. 9, 7 A.M., she was resting near the workers and their brood and at first it looked as though she might be adopted, but at 6 P.M. she was found dead.

Experiment 46. Aug. 6, 9 A.M., a fine *Polyergus* female was placed in a nest with 9 rather small *schaufussi* workers and about 100 cocoons. One of the workers was a very young, another an older callow able to carry cocoons. The female ran about the nest and was soon attacked by a worker, which she promptly disabled by piercing one of its eyes and optic ganglia, so that it kept turning around in a counter-clockwise direction. Then she was attacked in succession by 4 other workers. She killed one of these and maimed the three others. Whenever one of them tweaked her legs, she ran her mandibles through its head. Two of the three injured workers kept gyrating, one in a clockwise, the other in a counter-clockwise direction, showing that in the former the left, in the latter the right side of the head had been pierced by the female's mandibles. At 10 A.M. she was attacked by two workers, one of which she had previously wounded. This one she killed in the usual manner. Throughout the day she showed neither interest in the brood nor fear of the *schaufussi.* By noon there were only 3 uninjured workers in the nest and these kept attacking the female from time to time. During the greater part of the afternoon she rested quietly on the sponge. Aug. 7. 6 A.M., she was resting on the cocoons with the workers, of which only 4 survived uninjured. At 6 P.M. she was dead.

The above experiments show that the female *Polyergus lucidus* is not adopted without, at least, considerable reluctance on the part of the *schaufussi* workers, and that she manifests no interest in the brood and is ready to kill the workers in self-defense. There is none of the strange excitement and keen interest manifested by *F. rubicunda.* It seems certain that the female *Polyergus* would accept adoption if the workers showed any disposition to confer it upon her, but they have no such inclination. The two following experiments show very clearly the female's lack of interest in the brood.

Experiment 47. Aug. 27, 11 A.M., a female *Polyergus* was placed in a nest with 3 *schaufussi* workers of medium size and a number of worker cocoons. She seized one of the workers at once and perforated its head. The worker began to gyrate in a counter-clockwise direction, but still endeavored to carry a cocoon to a place of safety. The female soon injured another aggressive worker, that nevertheless kept returning again and again to the attack. This worker died at 12 M., and the single remaining one had lost an antenna and was staggering along with a cocoon. By 6 P.M. this worker had also been killed and the female was resting quietly on the moist sponge. During this and the two following days she paid no attention whatever to the cocoons which were scattered about the nest. At 6 P.M., Aug. 29, she was returned to the parent nest and the experiment was concluded.

Experiment 48. Aug. 27, 12 M., a fine female *Polyergus* was placed in a nest with 4 large *schaufussi* workers and about 100 worker cocoons, all taken from a large wild colony. The female at once killed a worker that she encountered while running about the nest, and a few moments later dispatched two others in quick succession. The single remaining worker ran about with a young larva in its mandibles, trying to escape from the female. The latter returned again and again to the murdered workers and thrust her mandibles through their bodies. She paid no attention to the cocoons. By 9 P. M. she had killed the last surviving worker. During the two following days she ran about the nest or rested for long periods on the moist sponge, but never gave the least heed to the cocoons which lay scattered about the nest as they had been dropped by the demoralized workers. At 6 P. M., Aug. 29, she was removed from the nest.

In the two preceding experiments the *Polyergus* females were very aggressive and showed much of the insensate eagerness to kill alien workers so characteristic of the *Polyergus* workers. Neither in these nor in the succeeding experiments was a female ever seen to touch a cocoon with her mandibles, though often compelled to feel them with her antennæ and to walk over them while moving about the nest. In the two following experiments the behavior of the female *Polyergus* presents still another aspect, as passive as the preceding was agressive.

Experiment 49. Aug. 27, 11.30 A.M. A fine *Polyergus* female, placed in a nest with 14 large *schaufussi* workers and several cocoons, was soon seized by a worker. She pierced its cranium with her mandibles and compelled it to release its hold. While she was extricating herself from the jaws of this worker she was attacked by another, but did not offer to defend herself. Some of them pulled her about by the legs or antennæ while others fired volleys of formic acid into her face. She eventually escaped and without any signs of fear or resentment ascended the pile of cocoons. Here the workers seized her again and dragged her away. She drew her limbs up against her body and remained in a quiescent, pupal attitude while they tried to pierce her shining integument with their sharp mandibles. At noon she was still being dragged about passively. At 1.35 P.M. she was attacked simultaneously by 5 workers. By 6 P.M. they had succeeded in injuring her and she was so weak that she was removed from the nest.

Experiment 50. Aug. 27, 6.20 P.M. Another *Polyergus* female was placed in the nest employed in the last experiment, which still contained 13 *schaufussi* workers. There was a great commotion among the latter as they fled with their cocoons. She was seized by one of the workers but did not retaliate. She was almost at once released and went to rest in a corner. Aug. 28, 7 A.M., she was still alive, quietly resting on the moist sponge at some distance from the workers and their brood. At 9.15 P.M. she was walking about the nest. Whenever she passed workers they threatened her with half-open mandibles but went no further. She was not in the least aggressive. Aug. 29, 7 A.M., matters were *in statu quo.* A worker came up and pulled the female's leg, but soon released her. She rested near the workers and spent much of her time cleaning herself. By 6 P.M. there were 3 dead workers in the nest, showing that she must have resented some of the indignities to which she had been subjected during the day, for the workers seized her from time to time and dragged her about the nest by a leg or an antenna. When released she escaped to a corner of the chamber but soon returned to the workers and brood as if seeking adoption. Often the workers came up and felt of her and then passed on without molesting her. Aug. 30, 7 A.M., during the night another worker had been killed. The female was still in excellent condition. She was pulled about by a large worker but offered no resistance. Others repeatedly pulled her away from the brood, but as soon as she was released she returned to the workers' corner. Aug. 31, 7 A.M., she was uninjured and hung about the workers' corner all day. By 6 P.M. she had lost her left antennal funiculus and was so weak that there was no hope of her survival. She had lived 5 days in a nest with 9 to 13 unusually large *schaufussi* workers.

In these two experiments the behavior of the *Polyergus* female was much like that of *F. consocians* in *incerta* nests and strongly suggested adoption as the method of colony formation. I planned a number of other experiments in the hope of gaining a clearer insight into the peculiar behavior of the *Polyergus* females, but was prevented from carrying them out by the rapid dying off of these insects in their own nest. Hence this portion of my work, like that on *F. subintegra* and *aserva*, will have to be continued another summer under more favorable circumstances.

GENERAL CONSIDERATIONS.

The foregoing simple experiments, which consisted in compelling female ants, mature but mostly unfertilized, and artificially deälated, to consort with small colonies of alien workers, all go to confirm, what has long been known, that worker ants of one species are hostile to females of another species. It is clear, however, that this hostility is not always manifested with uniform intensity. Towards the females of the *Formica rufa* and *exsecta* groups, it is often feeble or even evanscent, so that in these cases mixed colonies can be produced consisting of adult individuals of both species. Under normal conditions such colonies are necessarily temporary, since they are destined, after the death of the original workers, to resolve themselves into pure colonies of the species to which the fertile queen belongs. Towards the females of *F. sanguinea* and *Polyergus* the hostility of alien workers is so pronounced and persistent that mixed colonies cannot be produced as in the former case. The females are obliged to exterminate the old workers and to take possession of the brood in order to rear a colony of loyal auxiliaries; it being well known that ants hatched in the presence of adult individuals of another species are less liable to attack these even when they are recognized as aliens.

Of the rather numerous species of the *rufa* and *exsecta* groups, *F. consocians* has furnished us with the clearest case of temporary social parasitism through the immediate adoption of the fertilized female by *incerta* workers. Not only is the *consocians* female apt to arouse little or no hostility in the *incerta*, but she displays in her own behavior a pronounced instinctive adaptation to an inquilinous or parasitic mode of life. When placed in an empty chamber communicating with one occupied by *incerta* workers and their brood, she does not hesitate to enter and approach the workers with fearless and conciliatory gestures. She at once manifests a keen interest in the persons of the workers and their callows, and if driven away or persecuted returns again and again without signs of fear or resentment. Her attitude throughout is consistently insinuating. She licks the workers continually and effusively, and, at least till she has been definitively adopted, will even deign to feed them from her own crop. Her behavior is often surprisingly like that of the workers of *Leptothorax emersoni*, a highly inquilinous ant described in two of my former papers.[1]

This unusual behavior of the *consocians* queen endows some of her physical characters, which would otherwise be difficult of explanation, with a peculiar significance. I allude especially to her diminutive stature and uniform yellow coloration. Both of these peculiarities may be mimetic, since they must enchance her resemblance to the *incerta* workers, and may therefore facilitate an alliance between the two species. The fulvous yellow hairs on the body of the *consocians* female are also suggestive of myrmecophily, since it is known that many myrmecophilous arthropods, especially beetles, belonging to the most diverse taxonomic groups, present a peculiar convergent character in the form of tufts of yellow hairs connected with osmateria. These hairs are licked by the ants with unmistakable signs of satisfaction.

It is probable that the diminutive stature, though it may be regarded as a mimetic character, has not been developed as such, but is rather a result of precocious development. This, in turn, must be due to underfeeding during the larval stages. I have shown (p. 50) that in wild nests the *consocians* females make their appearance in great numbers and before the summer brood of workers hatches. This fact, taken in connection with the observation that colonies of our other species of *Formica*, notably those of the *fusca* and *pallide-fulva* groups, annually produce comparatively few but very large queens, indicates that the stature of the female ant must depend on the colonial food-supply and the manner of its distribution to the larvæ. While each of the large females has her gaster well stored with adipose tissue carried over from larval life, voluminous wing muscles that may be disintegrated after deälation to form additional nutriment, and ovaries containing mature or nearly mature eggs, the tiny female *consocians* is conspicuously lacking in all of these particulars and is therefore compelled to associate with worker ants in order to secure food not only for her prospective brood but for her own frail body.

---

[1] The Compound and Mixed Nests of American Ants. Am. Natur., XXXV, 1901, p. 431 *et seq.*; and Ethological Observations on an American Ant (*Leptothorax emersoni* Wheeler). Archiv f. Psychol u. Neurol., II, 1903, pp. 1–31.

The foregoing considerations satisfactorily account for the belated fertility of the female *consocians*. In one of my colonies (Colony C, *vide supra* p. 62), which was kept from August, 1904, till September, 1905, the ovaries of the queen did not enlarge and produce eggs till late in the spring, although the ants were so abundantly supplied with honey and hashed meal-worms that the gasters of the *incerta* workers were full and tense throughout the fall and winter months. This belated fertility under what seemed to be unusually favorable conditions is in marked contrast with what may be observed in some other ants. Thus Emery[1] found that the female *Pheidole pallidula* laid a great number of eggs on the day following the nuptial flight, and that a female of *Liometopum microcephalum* fertilized July 1, laid some 20 eggs four days later. The above-cited observation of Jakob Huber (p. 44) shows that the female *Atta sexdens* lays on the third day after her nuptial flight. I have observed that the females of *Pogonomyrmex molefaciens* will begin to lay within four days after fertilization. In all of these cases the females are very large compared with their workers. It is probable that great variations will be observed in the length of time that elapses in different species of ants between fecundation and laying. These variations are, of course, easily explained as due to differences in the amount of food stored up during larval life. If we regard the female ant as the winged germ of the colony, we are led to look upon her size as we look upon the size of the eggs in various animals. It is well known that the more numerous the eggs produced by an organism, the smaller they are apt to be and the greater or more numerous the vicissitudes to which they are subjected during their development. This is especially true of parasitic animals like the Cestodes, Meloid beetles, etc. Similarly in ants, the larger the females the smaller the number of them produced by a single colony, and the fewer the vicissitudes they must encounter in founding their colonies. The analogy holds good also in respect of parasitic species like *F. consocians*.

---

[1] Sur l'Origine des Fourmilières, *loc. cit.*, p. 460

It is, I believe, admissible, as I have asserted in a former paper, to extend the conclusions derived from a study of *F. consocians* to several other species of *Formica* belonging to the *rufa* group and having similarly diminutive or otherwise aberrant females. The species of *Formica* which I have described under the names of *microgyna*, *montigena*, *nevadensis*, *impexa*, and *nepticula* all have diminutive females, and small colonies of the two first mixed with *F. subsericea* workers have been actually observed. The females of *F. oreas*, *ciliata*, *dakotensis* and its var. *wasmanni* are aberrant in coloration and, though larger than the females above mentioned, are nevertheless smaller than those of the *fusca* and *pallide-fulva* groups. The very long yellow hairs of the female *ciliata* are especially remarkable and indicate that this insect must be a genuine inquiline. Mixed colonies of *wasmanni* with *subsericea* have been observed by Muckermann. Even *exsectoides* and the various varieties and subspecies of *rufa*, which have larger queens than the preceding species, are in all probability temporary social parasites. Several young colonies of *exsectoides* mixed with *subsericea* have been observed, and Wasmann has found, as I predicted, that the European *F. truncicola* presents essentially the same conditions as *consocians*. The behavior of *F. integra*, as shown in the above experiments, is clearly suggestive of inquilinism. I have also added a Myrmicine ant, *Stenamma* (*Aphænogaster*) *tennesseense* to this series of forms, since there is evidence that its diminutive, very glabrous and bright red females start their colonies with the aid of workers of *S.* (*A.*) *fulvum* or some one of its varieties.

Questions concerning the phylogenetic origin of parasitic habits are notoriously difficult to answer. The obstacles to an explanation of certain cases of social parasitism, however, like those seen in *F. consocians*, *truncicola*, etc., seem to have less weight than in the case of ordinary, or nonsocial parasitism. From the very nature of social organization in ants, the female may be regarded, throughout a large portion of her life, as a parasite on the workers of her own species. As a virgin she is a parasite on the maternal colony, as a mother, on her own offspring; so that both by instinct and tradition she has a pronounced proclivity to seek the society of workers and to rely on them both for her own sustenance and that of her brood. Hence it is not surprising to find that the females of some species may return after the marriage flight to seek readoption in the parental nest. In other cases fertilization may take place within the nest and the females, after losing their wings, remain as so many additional mothers to re-enforce the reproductive energies of the colony. One or both of these methods is adopted by most of our species of *Formica*, and must, indeed, be assumed in order to account, first, for the normal occurrence of more than one deälated female in nearly every large colony; second, for the multiplication of nests by a single colony and third, for the longevity of certain colonies far exceeding that of individual queens. From single colonies of *F. gnava* in Texas I have taken from 30 to 50 deälated females, and Wasmann[1] dug 60 old females from a single nest of the European *rufo-pratensis*. He also publishes a number of notes on the great tendency of *F. rufa* to form nests by a process of budding, so to speak, from a single original formicary, a phenomenon that had been previously observed by Forel and others, and also in the North American *exsectoides* by McCook. (*Vide supra* p. 72) Forel[2] mentions a colony of *F. pratensis* which he has had under observation for nearly forty years. It is extremely populous and has taken possession of a whole pine grove. On digging into this nest recently he found fertilized and unabraded females that certainly must have been much younger than the colony.

We may conceive that the next step in the phylogenetic development of temporary social parasitism was taken when, after descending from their nuptial flight, the females sought adoption in nests of their own species but belonging to alien colonies. As such adoption may be easily effected in artificial nests of some species of ants, there is no reason to suppose that it does not occur in wild colonies. In fact, Wasmann's observations[3] go to show that in Europe such adoptions not infrequently occur between workers of one and females of another variety or subspecies of *F. rufa*. He says that "in *rufa* and *pratensis* colonies, but especially in *rufo-pratensis*, *rufo-truncicola*, etc. females with *rufa*, *pratensis* or *truncicola* coloration are often found together."

Such conditions, which can be explained only as the result of adoption, lead to the final phylogenetic stage represented by the adoption of a female of one species by workers of another. It must be admitted that at this point the difficulties in the way of adoption become more serious. There is unquestionably a pronounced antipathy among ants to the formation of mixed colonies by consociation of adult individuals, unless the insects themselves have exceptional characters or happen to be living under exceptional conditions. The female, on the one hand, must have instincts that lead her to behave in a conciliatory manner when she is surrounded by alien and hostile workers, and in all probability also a peculiar neutral, agreeable, or, at any rate, pacific odor. On the other hand no prosperous ant colony adopts females of alien species. They could be tolerated only by small, depauperate or effete colonies which had lost their queen or queens and were on the verge of extinction, or by incipient colonies under similar untoward circumstances. Even under these conditions adoption may be rare and exceptional, so that it may chance to occur only in the nests of very abundant and widely distributed species like *F. fusca* and *pallide-fulva.* But the good fortune of being able to found a colony with the aid of alien workers, though so rare, may still be sufficiently frequent to insure the survival of the species of the *rufa* and *exsecta* groups, especially as these insects, when once established in a neighborhood, are able to produce enormous and long-lived colonies.

---

[1] Ursprung u. Entwickelung der Sklaverei bei den Ameisen, *loc. cit.*, p. 196.

[2] Ueber Polymorphismus und Variation bei den Ameisen. Zool. Jahrb. Suppl., VII, 1904, p. 580.

[3] Ursprung u. Entwickelung, etc., *loc. cit.*, p. 198.

Miss Fielde[1] has recently published some observations and conclusions which would seem to contradict not only the views which I have advanced in this and several other papers, but also those of Forel and Wasmann. She sums up her experience in the following sentences: "In no species of ant have I found workers that would tolerate the presence of any queen of unfamiliar odor, nor any queen that would willingly remain among workers of unfamiliar odor. Although all species of ants have not been tested we may well assume that what is shown to be a fundamental trait in a few species will manifest itself in all species of the tribe."

While I do not doubt the accuracy of Miss Fielde's observations I am not prepared to accept her conclusions in the comprehensive and somewhat schematic form in which they are stated, since they seem to me to be subject to the following limitations:

First, although simple at first sight, Miss Fielde's hypothesis becomes very complicated on closer scrutiny. If I understand her correctly she recognizes definite reactions to odors which differ with the species (specific odors), a "nest aura," an odor of the trail, a female and worker odor, that is, an odor which undergoes progressive change during the life of each individual, at least in the workers (progressive odor). She assumes on the part of the ants not only a highly developed associative memory for these various odors, but also a transmission of odors by heredity. In other words, we must suppose that every worker has an individual odor, which is continually changing with age, and identical only with the odor of the other workers of the same age and lineage in the same colony. I am not prepared to deny the existence of all these odors, although I find it difficult to understand how animals even as highly endowed as ants can behave with anything approaching diagrammatic accuracy in the presence of such a bewildering multiplicity of stimuli. The facts certainly appear to be much simpler than the hypothesis which Miss Fielde advances for their explanation. It would seem that the specific and nest odors and the reactions which they call forth would be amply sufficient to prevent two or more colonies of the same or different species from fusing to form a single colony. This interpretation, which is really the basis of Miss Fielde's elaborate schema, has long been accepted by myrmecologists and repeatedly applied to particular cases.

---

[1] The Progressive Odor of Ants. Biol. Bull. X, No. 1, Dec., 1905, pp. 1–16.

Second, while so much of Miss Fielde's contention may be granted, there can be no question that she has failed to account for the numerous exceptions which Forel, Wasmann and myself have been endeavoring to elucidate. These she practically ignores. The species used in her experiments, at least so far as they are mentioned in her paper, are well known nonsymbiotic species. Nor does she refer to any of the recorded cases in which female ants have been shown to be readily adopted by adult workers of the same species from very different colonies. In some of our species such adoptions may be immediate and complete, for example in *Stigmatomma pallipes*, *Pogonomyrmex molefaciens*, *Eciton schmitti*, *Leptothorax emersoni* and *Myrmica brevinodis*, according to my own observations, and in *Atta sexdens* according to Huber (*vide supra*, p. 46).

Third, the cases just cited, together with the adoption of queens by adult workers of alien species, of which several examples are recorded in this paper, are *facts*, and can only be explained by assuming on the part of the adult ants a very considerable amount of plasticity and adaptability to unfamiliar odors. It seems to me that Miss Fielde fails to make due allowance for this factor in her interpretation. This plasticity is conspicuously attested and exploited by the hundreds of myrmecophilous insects known to science. The toleration and adoption of the females of ants like *Anergates atratulus* and other workerless species, which are not only obligatory but permanent inquilines, *Leptothorax emersoni* and *Formica consocians*, which have unmistakable inquilinous instincts, not to mention other species, are to be interpreted in the same manner as the toleration and adoption of myrmecophiles. These ants are, in a word, merely myrmecophilous insects.

Fourth, animosities among ants are certainly not, in all cases, reactions to unfamiliar odors. The tactile sensations, which are associated with those of odor in these insects, may be very important and cannot be readily isolated in experiments like those undertaken by Miss Fielde. In several of my experiments on *F. consocians* it was seen that sister queens that had been living in perfect amity in the parental nest attacked one another furiously when placed in a nest containing *incerta* workers. Such animosity could hardly be aroused by odors. If something akin to this mutual hostility in deälated and fertilized females were not the general rule among sister ants, they would often establish their colonies in partnership, but only one such case has hitherto been observed in a state of nature. (*vide supra* p. 41).

Contrary to the hypothesis advanced almost simultaneously by Wasmann[1] and myself,[2] I now believe that slavery, or dulosis, has no direct ontogenetic or phylogenetic connection with the condition I have called temporary social parasitism. Although only one of the forms with which I experimented, namely *F. sanguinea rubicunda*, gave positive and clean-cut results, the behavior of the others, *F. sanguinea aserva* and *subintegra* and *Polyergus lucidus*, though much less satisfactory, was deficient rather than opposed to the results derived from *rubicunda*. That *aserva*, *subintegra* and *Polyergus*, in founding their colonies, may present conditions intermediate between those of *rubicunda* and *consocians* is, of course, possible. I have given reasons for believing that under natural conditions the recently fertilized female of *F. rubicunda* enters some small colony of *subsericea*, a species with which, of course, she has been familiar during her whole prenuptial life in the parental nest, kills the workers, if they attack her, seizes the larvæ and pupæ, stands guard over them and helps them to hatch. These workers then function as so many loyal nurses in feeding the queen and rearing her young as soon as they are brought forth. When the latter have reached maturity, they show the dulotic instincts of their mother in a modified and exaggerated form, making concerted forays on neighboring *subsericea* colonies, kidnapping their brood, and thereby perpetuating the mixed colony.

---

[1] Ursprung und Entwickelung der Sklaverei, etc., *loc. cit.*

[2] An Interpretation of the Slave-making Instincts in Ants. Bull. Am. Mus. Nat. Hist. XXI, Feb. 14, 1905, pp. 1–16.

While the incipient dulotic colony is, to all appearances, very similar to that of a temporary parasite like *F. consocians*, there is an important difference in the comparative ages of the personnel in the two cases: In the incipient dulotic colony the workers are all younger than the queen, whereas in the incipient *consocians* colonies some or all of the workers are older than the queen. In the case of *rubicunda*, the *subsericea* workers kidnapped as pupæ by the queen are in full vigor and may live for three or four years, thus constituting a most efficient *entourage* for the education of the firstling *rubicunda* brood. In the colony of the temporary parasite, on the contrary, the conditions after adoption are less favorable, but there is a compensatory advantage to the species in the comparative ease with which adoption may be effected. The *rubicunda* queen is bound to retain her large stature, vigor and pugnacity. She may be conciliatory or indifferent towards the *subsericea* till she is attacked, but then the fiery temper, so characteristic of her species, asserts itself and she makes short work of the hostile workers. In the above experiments the series of actions of which this massacre is the first, is so constant, precise, and purposeful that it must represent a perfectly normal episode in the life of the female *rubicunda*, whenever she is subjected to the proper stimulus in the form of a small colony of hostile *subsericea* workers with their brood.

Since my experiments were concluded I have received from Prof. Emery a paper[1] in which he predicts for *Polyergus* a method of colony formation similar to that observed in my artificial nests of *rubicunda*. He says: "And what of the parasitic and slave-making ants like *Polyergus*? Wasmann has formulated for this species an hypothesis which is not altogether satisfactory. He assumes the formation of the colony by alliance between a female *Polyergus* and alien workers of *Formica fusca* or *rufibarbis*. I would hazard a different supposition. Forel's observations seem to show that the instincts of the female *Polyergus* are less degenerate than those of the worker; he has even seen a female aiding a hatching callow to escape from its pupal envelope. Moreover, both Forel and I have seen virgin females taking part in slave-making expeditions. I surmise, therefore, that the female *Polyergus*, after losing her wings, is able to plunder from some feeble *Formica* colony one or more worker pupæ, which will then give rise to her first auxiliaries." So far as they go, my observations on *P. lucidus* are in accord with this hypothesis. It is certainly remarkable, however, that my queens were never seen to manifest the slightest interest in the larvæ or pupæ, even after all the workers in the nest had been dispatched. One of these insects could perhaps succeed in founding a colony if, after killing all the *schaufussi* workers in a small nest, she simply remained with the brood till some one of the pupæ hatched. This, however, could not occur without the aid of the female unless the pupa happened to be naked or very young callows happened to be present.

---

[1] Sur l'Origine des Fourmilières, *loc. cit.*, p. 461.

It is clear, just as in the cases of temporary social parasitism, that a *sanguinea* or *Polyergus* queen could not enter a flourishing colony of the auxiliary species with any prospect of being tolerated, much less of being permitted to establish a colony of her own. In addition to the two kinds of colonies available for this purpose, the incipient and the moribund, which were postulated in the cases of temporary parasitism, there is also a third possibility, namely, the fragment of a dispersed colony. In regions where *Polyergus* and *sanguinea* occur one often finds that the workers of *subsericea* and *schaufussi* colonies that have just been plundered by the dulotic ants scatter and again congregate in small clusters, each with such larvæ and pupæ as it has been able to rescue, under the dead leaves or stones, to remain for hours or days in a state of "abulic dejection." One of these clusters would afford every opportunity to a young *sanguinea* or *Polyergus* queen in search of a brood. It is highly probable that on the approach of one of these queens, such a cowardly colony-fragment would take to flight and surrender at least a portion of its cocoons.

If dulotic colonies are founded as here maintained, it follows as I have said before, that we can hardly look to temporary social parasitism as the phylogenetic basis of dulosis. Hence I ought perhaps to be well satisfied when Wasmann[1] calls my former view "eine nur undeutlich erfasste Hypothese," in order that his own "allseitig durchdachte und abgerundete Theorie" may shine forth with greater effulgence. That he should indulge in such boasting after reading my foot-note on the behavior of the *rubicunda* female shows that he failed to grasp the full import of my paper.[2] The present paper will, I believe, make it apparent that he forgot to round off at least one very important side of his "Theorie."[3]

---

[1] Nochmals zur Frage über die temporar gemischten Kolonien und den Ursprung der Sklaverei bei den Ameisen. Biol. Centralbl., XXV, Oct. 1, 1905, p. 648.

[2] Some Remarks on Temporary Social Parasitism and the Phylogeny of Slavery among Ants. Biol. Centralbl., XXV, Oct. 1, 1905, pp. 639, 640 *nota*.

[3] It would be unnecessary to return to this controversy, since Wasmann concedes the only point I had a right to demand, namely the acknowledgment of my priority in the discovery of temporary social parasitism as a regular occurrence in ants of the *rufa* and *exsecta* groups, were it not that he seeks to deflect his reader's attention from this single matter, which constituted the whole issue. He is, of course, at liberty to say that he made the discovery independently, but the fact remains that he had received and read my paper by October 21 and did not send his manuscript to the editor of the "Biologisches Centralblatt" till the early part of December, as is perfectly clear both

Wasmann, who has for years been studying the typical *sanguinea* in a region where it seems to be very abundant, has concentrated his attention on the dulotic instincts of the workers. To discuss the views he has advanced on this subject is unnecessary, because I believe that they are the result of seeking answers to questions that should have been propounded in a different way. The same is true of much of the general discussion which some years ago culminated in a well-known controversy between Weismann and Herbert Spencer on the all-sufficiency of natural selection. All along it has been tacitly assumed that the workers have peculiar instincts of their own, differing qualitatively from those of the queens of the corresponding species; and since the workers are normally infertile, there was great difficulty in accounting for the adaptive structures and behavior inherited through an organism that did not exercise nor even manifest them. The first question should really be: Does the worker have any physical or psychical characters that are not somehow represented in the female? In other words, are not the worker characters adaptively correlated excess or defect, that is, merely quantitative characters of the queen, characters differing from those of the queen after the manner of fluctuating variations and not of mutations? Had such questions been asked at the outset, a painstaking and comprehensive study of the female ant would probably have been inaugurated. And had this been done, I feel sure that much less would have been written about the differences in intelligence, instincts, etc. between workers and queens. The idea that the fertile female contains all the potentialities of the species would have been familiar. It would have been seen that in the workers characters such as structures, instincts, physiological reactions as expressed by longevity, resistance to maxima and minima of temperature, moisture, poisons, etc., are commonly less developed than in the queens. Some characters, however, are more strongly developed in the workers. It is true, for example, that some of the worker instincts, such as the foraging instincts, are supposed to be absent in the queens, but I have seen old, dealated females of *Trachymyrmex septentrionalis* not only in the act of excavating the nest in company with the workers, but actually collecting and carrying in caterpillar excrement on which to grow the fungus garden. Emery and Forel long ago observed *Polyergus* females accompanying the dulotic expeditions of the workers. It is also well known that young

---

from his own statement and that of the editor. I still maintain that observations on mixed colonies comparable to those of *F. consocians* were far too meagre, prior to the appearance of my paper to justify Wasmann's claim of independent discovery. It certainly does not help his case to write at length about all kinds of adoption among ants when there was only one kind under discussion.

female ants sometimes behave like the workers in caring for the young, feeding other members of the colony, etc. Because female ants are slow to manifest certain reactions, or fail to do so entirely, except under the stress of unusual stimuli, we should not say that the capacity is absent, any more than we admit the absence of an hereditary character which remains latent during one or more generations. To use the language of the neovitalist, the entelechy of the worker ant is involved in that of the female. While the instincts of the worker ants are very important in all that relates to the inheritance and maintenance of the colony—its *Betriebsfunktionen*, to use a German word—the instincts of the female are of supreme significance in all that relates to the reproduction of the species; to the ontogenetic and hence also to the phylogenetic development of colonies. This seems to have been overlooked in all previous attempts to explain social parasitism and dulosis. Wasmann, for example, continually stresses the dulotic activities of the workers and the impossibility of explaining them except as manifestations of an inordinate fondness for rearing the larvæ and pupæ of an alien ant, on the part of an enterprising and pugnacious species which would seem to be well able to hold its own in the struggle for existence without resorting to any such methods for the enlargement of its colonies.

There are obviously some further bearings of these general considerations on the subject of dulosis. It is possible, in the light of the experiments on *rubicunda*, to regard the slave-making instincts of the workers of this species as at most only exaggerations of similar instincts in the female. In the former, however, they are more suffused with the instinct to forage in files. As Forel and I have shown, a large portion of the larvæ and pupæ kidnapped by *sanguinea* workers must be eaten, although some of them are reared in obedience to the threptic instincts, which the workers, of course, share with the queens. It is not even necessary, however, to regard these instincts as unusually developed in the workers of the slave-making species. In the *rubicunda* queen, they naturally predominate, although in one experiment a single small *subsericea* larva was eaten. Unfortunately I failed to give much attention to the larvæ used in my experiments, which should therefore be repeated with a view to ascertaining whether the female *sanguinea* does not satisfy her hunger occasionally with some of the *fusca* larvæ if she is required to wait too long for the hatching of the pupæ.

As I have already intimated, there seems to be no way to derive the dulotic instincts from a condition of temporary social parasitism like that of *F. consocians*, *truncicola*, etc. Dulosis is rather to be regarded as a distinct manifestation, which has probably arisen independently from the same basis as temporary social parasitism. This basis, as we have seen, is the instinct to form polydomous colonies, like those of *rufa*, *exsectoides*, etc., by adopting females of the same species and multiplying nests. Wasmann has shown that the European *sanguinea* is very prone to proliferate over several nests. This seems to be true also of some of our American varieties and subspecies, although I have seen indications of it only in certain localities. Wherever it occurs it may be taken to indicate that some of the females after fecundation either remain in or return to colonies of the parental species. In founding new colonies, however, the females obey the same instinct which impels them to return to the parental nest, namely to enter colonies in which they find the already familiar *fusca* workers. To this extent, and, I believe, no further, have dulosis and temporary social parasitism a common phylogenetic origin.

Now if we regard the worker instincts as derived from those of the queen, instead of as activities *sui generis*, the matter will appear in a clearer light. The dulotic tendencies of the worker are then referable to the instincts which the female has occasion to display only while she is founding her colony. The differences are largely due to the fact that the workers make their forays not singly and but once in their lives but in companies and repeatedly and on populous *fusca* colonies which the females could not enter. Wasmann has explained the fact that the workers select the *fusca* colonies as the objects of their raids because this species happens to be a very familiar one, since it reared them in the parental nest. This is probably true, but it is even more evident in the case of the queen, since the tendency to invade such a nest is in her reinforced by the traditional purpose of establishing a colony.

Pursuing the matter still further, however, we come to deeper and more general instincts. At first sight the catenary reflexes manifested by the *rubicunda* in the experiments recorded on pp. 75 to 83 appear to be very unusual and quite in harmony with the unique and exceptional character commonly attributed to dulosis. It is probable, however, that young and vigorous females of nearly all species of ants, when confronted with a small number of hostile workers and their brood, either of the same or of an alien species, would behave very much like the queens of *rubicunda* : they would, in other words, slaughter the workers and take possession of the brood. The attacks of the workers would naturally goad the queen to self-defence and violence while the presence of the undefended brood would arouse her philoprogenitive cravings. These suppositions are worth testing by specially devised experiments. The behavior of the queens of the *rufa* and *exsecta* groups obviously constitutes a striking exception to these statements, since some of these in my experiments failed to resent the hostile tweaking and spraying with which they were received by the workers. It is probable, however, that in these species the instincts of self-defence are latent, or rather adaptively inhibited in the presence of workers of the host species. Through founding colonies with the aid of adult workers these females have become so completely socialized as to have lost nearly all hostile initiative.

It is not surprising to find that the psychologist and physiologist have followed the ethologist in concentrating their attention on the worker to the neglect of the female ant. The workers are, of course, more abundant, much simpler and more responsive to certain stimuli. The female ant, however, as the epitome of the species, not only presents a fresher and more extensive field for the study of formicid instincts, but one to which we must more and more resort in tracing the worker instincts back to their origins and meanings. While worker ants undoubtedly can and often do reproduce, and are therefore able to transmit their characters to the species as a whole, at least through male offspring, it is nevertheless certain that the specific characters are commonly and often exclusively transmitted by the queens.

The taxonomist, like the physiologist and psychologist, has unduly stressed the importance of worker ants and for the same reasons, namely that they are more abundant and often, indeed, the only procurable specimens of a species. As myrmecography progresses, however, the specific and generic characters will certainly be drawn more and more from the males and females and less from workers and soldiers. It is evident that the same rule will apply to the termites, as Sjöstedt[1] and Desneux[2] have shown in their opposition to Wasmann's tendency to establish genera on the characters of soldiers.

The results of ethological study should be an abiding source of suggestion to the comparative physiologist and psychologist. Not only is such suggestion one of the greatest contributions of ethology, but this science should itself continually welcome and utilize the results of physiology and psychology. In this connection the experiments on *F. consocians* and *rubicunda*, showing that the phototropism and instincts of the female ant can be changed or modified by such a simple and definite stimulus as artificial dealation have a peculiar interest. Some years ago my friend Prof. Loeb in an important paper[1] called attention to the fact that female ants *(Lasius niger)* are negatively phototropic till the time of the nuptial flight, when they become positively phototropic to a high degree, only to return to the negative state after they have lost their wings. The latter state is accompanied by a positive stereotropism, which induces the insects to work their way into crevices, under stones, into the soil, etc. One would be inclined to regard fertilization as responsible for this change from positive to negative phototropism, but mere removal of the wings with tweezers not only produces the same peculiar inversion of reaction towards the light, but also changes other reactions as well. Before deälation the insects exhibit many instincts supposed to be peculiar to workers; they eat from the manger and, like workers, may be very aggressive to strange ants, though they usually pay little attention to the workers or to the brood. After extirpation of the wings, however, they become interested in the brood and solicit food from their offspring. Later still they become exceedingly timid and sensitive to light, so that they conceal themselves at once when the nest is opened or disturbed. The physiologist would naturally seek the cause of these changes in metabolic processes. Obviously the primary stimulus to which the insect reacts is a privitive one, the absence of the wings; but the secondary, or true stimulus must be sought within the organism, and since, in this case, the female ant reacts the same with an empty as with a replete spermatheca, fertilization cannot be the cause of the conspicuous differences in behavior before and after deälation. Apparently metabolic changes in the thoracic musculature, initiated by the mere absence of wings and leading to fatty degeneration of the muscles and their replacement by gases, may be the secondary or true stimulus. This, however, would seem to be a purely physiological problem.

---

[1] Monographie der Termiten Afrikas. K. Svensk, Akad. Handl., XXIV., 4. Stockholm, 1900.

[2] Remarques Critiques sur la Division Systematique des Termitides. Ann. Soc. Ent. Belg. XLVIII, 1904, pp. 372–378.

To some it may appear that in the foregoing general considerations I have unduly exaggerated the importance of the female ant. It must be admitted that one can hardly fail to be biassed by merely concentrating one's attention on a particular object of investigation, for specialization must of necessity mean limitation and undue emphasis. While I do not flatter myself that I have escaped such influence in the present instance, I believe I have shown that we must gain a deeper insight into the activities of female ants before we can hope to solve many of the problems suggested by the instincts of the workers.

---

[1] Der Heliotropismus der Thiere und seine Uebereinstimmung mit dem Heliotropismus der Pflanzen. Würzburg, 1890, p. 64 *et seq.*

POSTSCRIPT.

While the foregoing pages have been going through the press, a few facts of considerable interest in connection with both temporary and permanent parasitism among ants have come to light.

Mr. A. P. Morse has sent me a number of ants which were apparently living as a mixed colony under the bark of a pine tree at Sherborn, Massachusetts. The specimens comprise workers of *Formica fusca* var. *subænescens* and workers and a female of *F. impexa*, which I originally described from the Porcupine Mountains of northern Michigan. The female is very small and closely resembles the females of *F. microgyna*, *nevadensis*, and *nepticula*. Probably, therefore, *F. impexa* is a temporary parasite like *F. consocians*.

Forel has just published the interesting observations of Dr. Santschi of Kairouan, Tunis, on the workerless ant *Wheeleria santschii*, which is a permanent parasite in the nests of *Monomorium salomonis*. (Mœurs des Fourmis Parasites des Genres Wheeleria et Bothriomyrmex. Rev. Suisse Zool., XIV, pp. 51–69, 6 figs.) The young fertilized *Wheeleria* females were seen to enter the *Monomorium* nests, and were at first pulled about by the workers. In the course of a few hours, however, these females were definitively adopted. Santschi has made the very significant observation that the *Monomorium* workers kill their own queen and transfer their allegiance to the parasites. It now seems probable that the absence of the *incerta* queens in colonies that have adopted *consocians* queens may be due to similar matricidal instincts on the part of the workers.

Forel in his 'Fourmis de la Suisse' described a mixed colony of the Dolichoderine *Bothriomyrmex meridionalis* and *Tapinoma erraticum* without being able to explain its origin. Santschi has just made several observations which indicate that the *Bothriomyrmex* females seek adoption in the *Tapinoma* nests, but as pure colonies of each of these species are common, it is probable that the parasitism is of the temporary type seen in *F. consocians*.

EXPLANATION OF THE PLATES.

PLATE VIII.

FIG. 1. — Queen of carpenter ant (*Camponotus pennsylvanicus*) with incipient colony consisting of three minim workers and a packet of young

larvæ, nesting in the deserted pupa case of a longicorn beetle (*Rhagium lineatum*) under pine bark. Slightly enlarged.

FIG. 2. — Incipient nest crater formed immediately after the nuptial flight by a queen of the California harvester (*Pogonomyrmex californicus*). Mojave Desert, near Needles, California. Nearly ½ natural size

FIG. 3. — Nest of young colony of *Lasius niger* var. *americanus* under stone, presumably in its second year, showing the original queen chamber after its extension by the workers. Colebrook, Connecticut. ⅔ natural size.

PLATE IX.

FIG. 1. — Nest of *Formica rufa integra* in a huge pine stump, showing vegetable débris accumulated by the workers in the crevices of the bark and around the roots. Colebrook, Conn.

FIG. 2. — Nest of same species in a large pine log, showing accumulation of débris stopping up the hollow end. Colebrook, Conn.

PLATE X.

FIG. 1. — Nest of *Formica rufa integra* under and between a pile of stones lying on a large boulder. In this case the workers had carried the débris to a height of nearly six feet above the ground and packed it in between the stones. Colebrook, Conn.

FIG. 2. — Superficial nest chambers of *Formica difficilis* var. *consocians* under a stone. ½ natural size. At *a* and *c* two *Microdon* larvæ are seen, at *e* and *n* two puparia of the same insect. The imago has left the puparium at *e*. Colebrook Conn.

PLATE XI.

FIG. 1. — Nest of *Formica schaufussi* var. *incerta* under the edge of a stone. The nest entrance is at *x*. About ⅛ natural size. Colebrook, Conn.

FIG. 2. — Surface galleries of a nest of the same ant under a stone. *x*, entrance to nest, *v*. opening of one of the galleries into the large surface chamber. About ⅕ natural size. Colebrook, Conn.

PLATE XII.

FIG 1. — Young nest of *Formica exsectoides*, hardly a foot in diameter and still covered with long grass. Colebrook, Conn.

FIG. 2.—Larger nest from the same locality, showing straws on the dome-shaped summit and small openings about the base.

PLATE XIII.

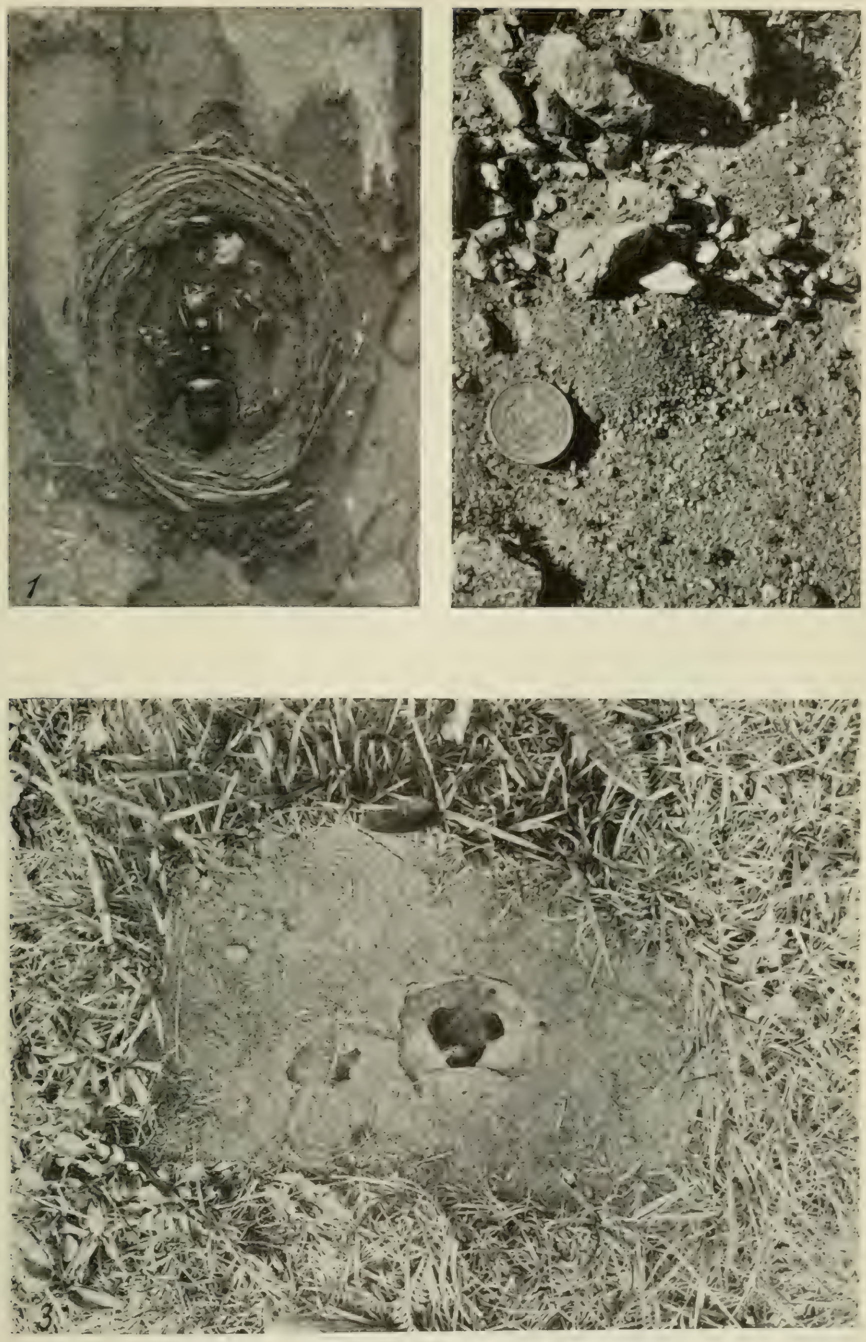
FIG. 1.—Nest of *Formica exsectoides*. Staten Island.

FIG. 2.—Nest of same species from the same locality, showing zone of green grass around the base and covering the entrance

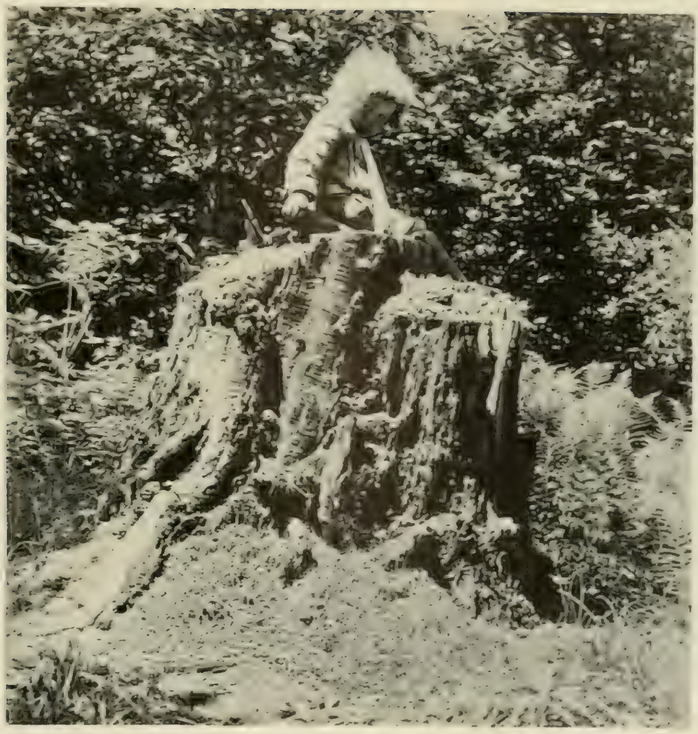
PLATE XIV.

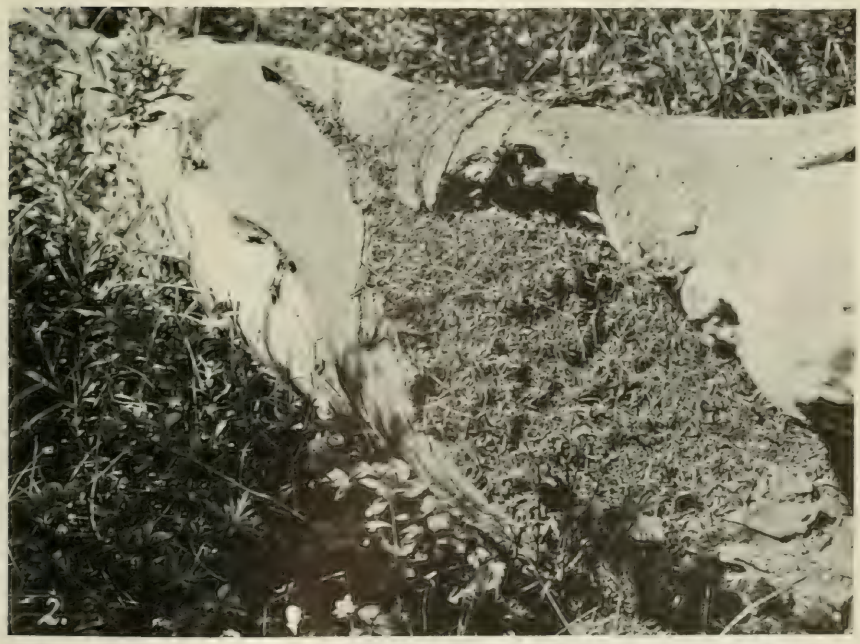
FIG. 1.—*Formica exsectoides* mound shot through with the stems of plants that have been killed by the ants. Staten Island.

FIG. 2.—Large mound nest of *Formica exsectoides*, showing the numerous entrances around the base, Colebrook, Conn.

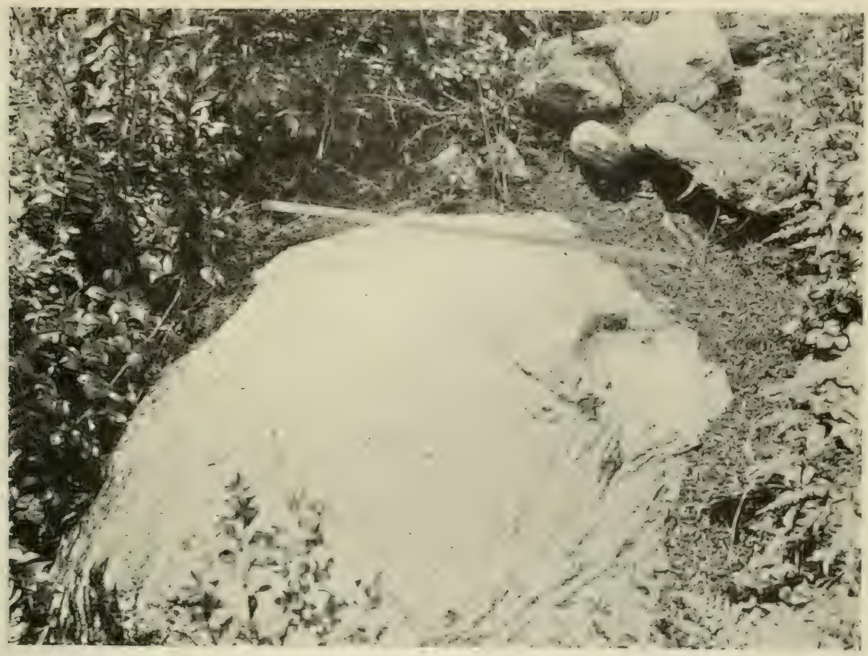


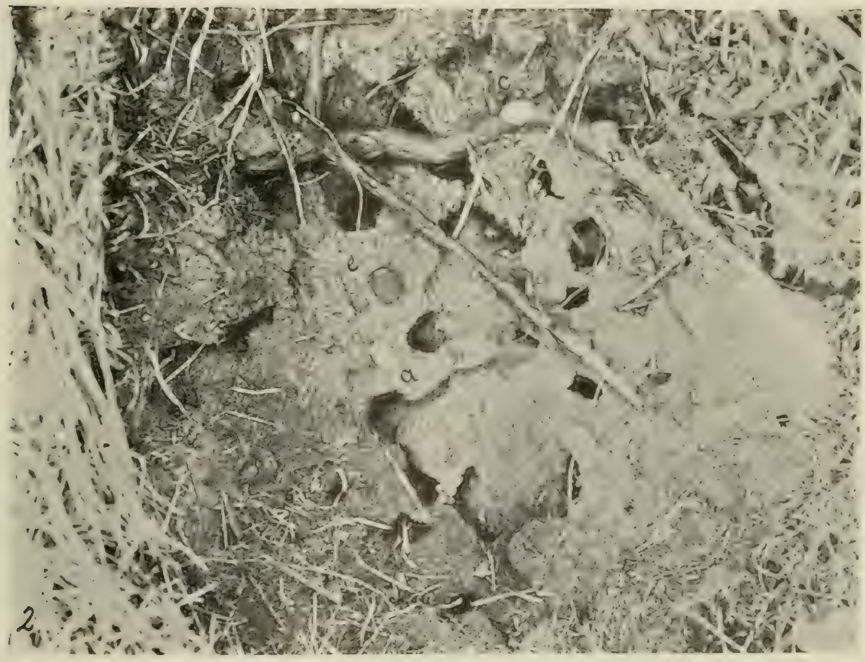
Incipient Ant Nests.



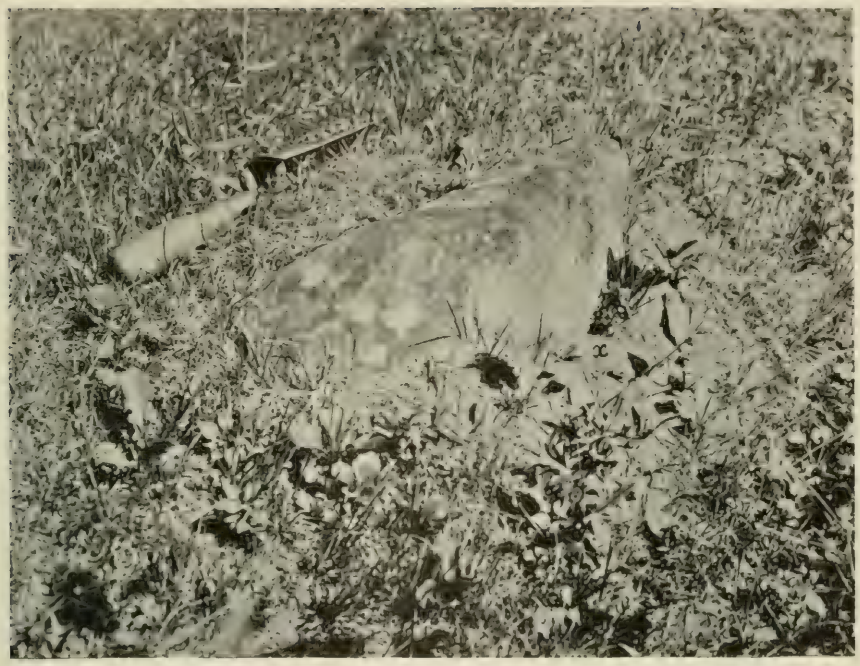


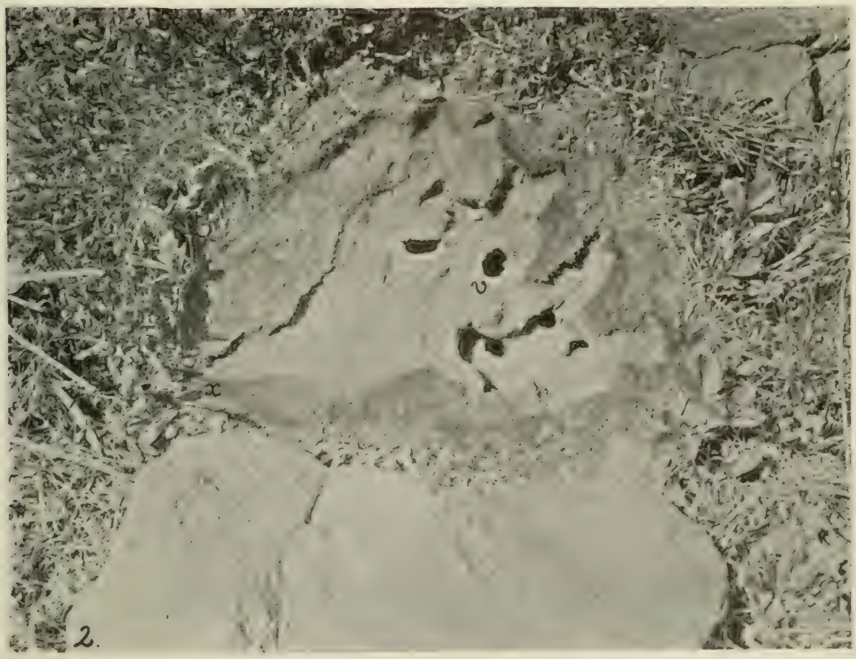
NESTS OF FORMICA INTEGRA.



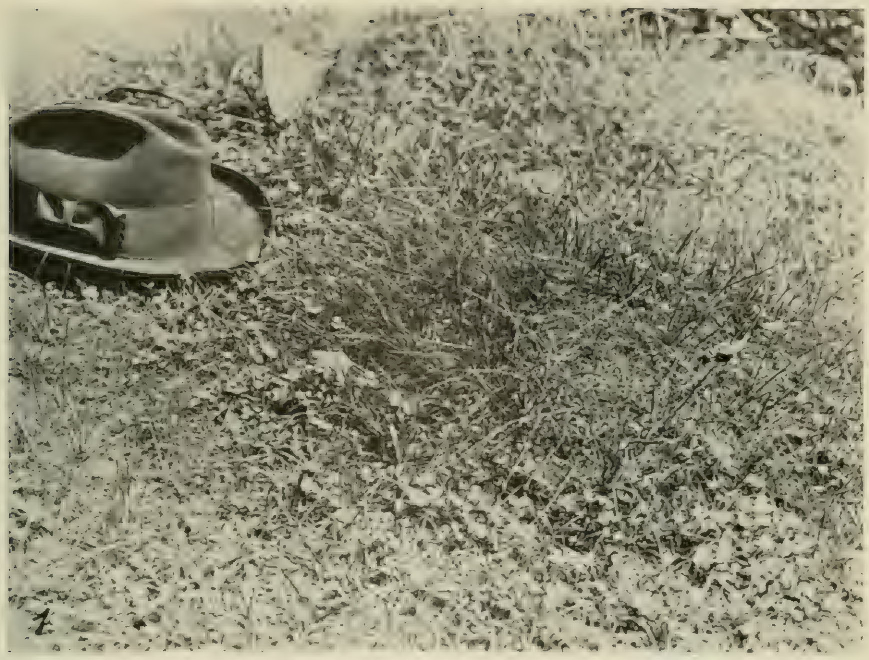


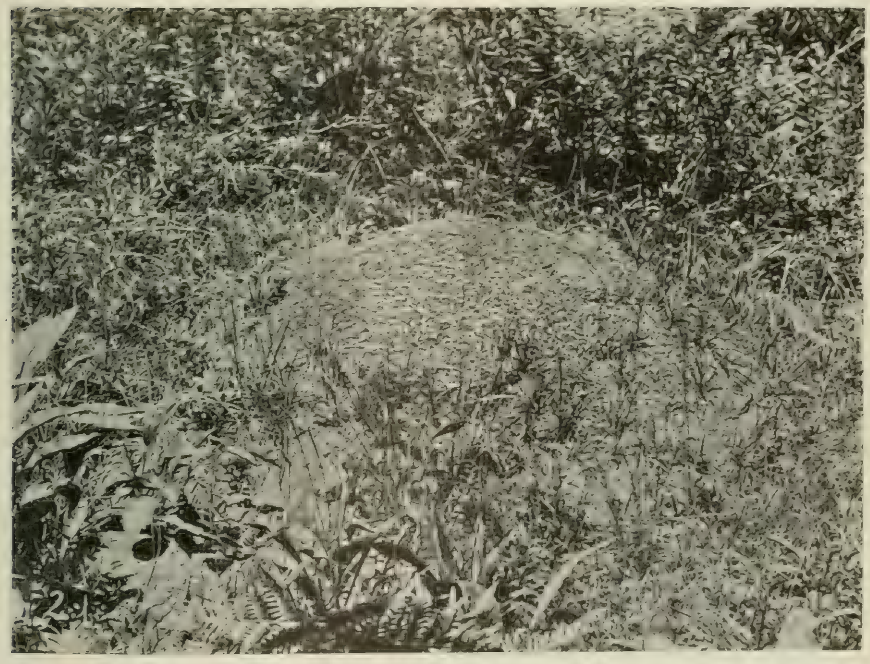
NESTS OF FORMICA INTEGRA AND F. CONSOCIANS.



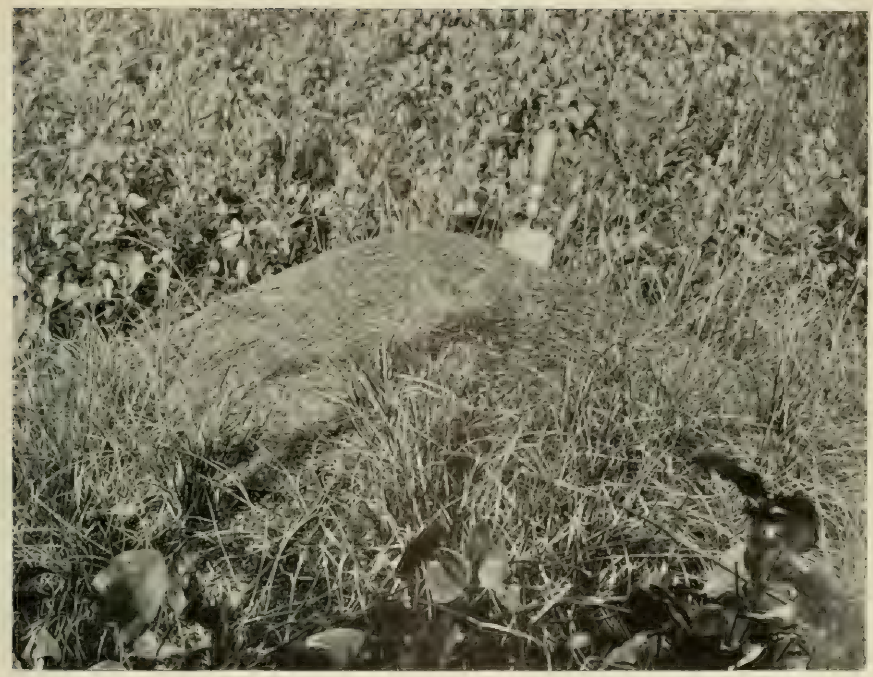


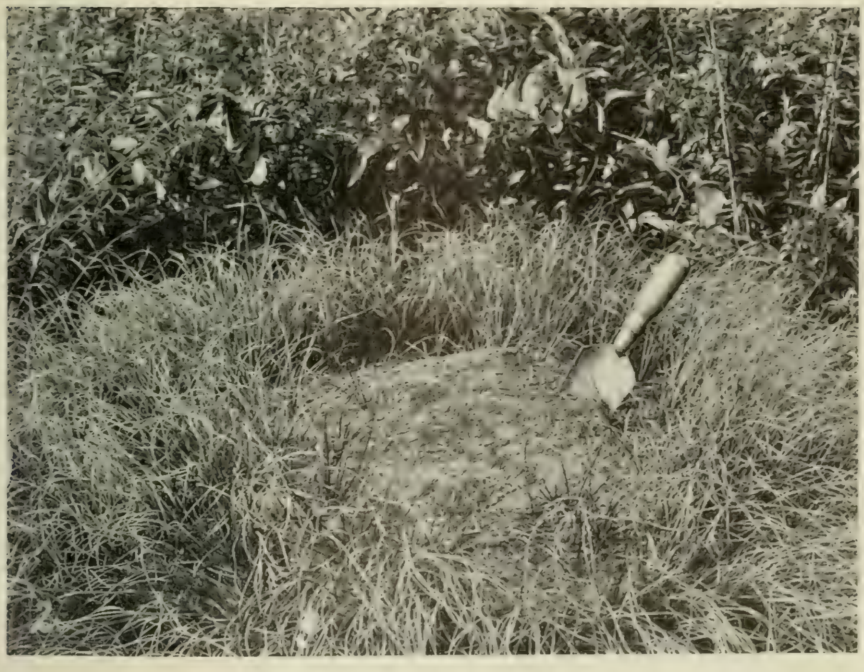
Nests of Formica incerta.



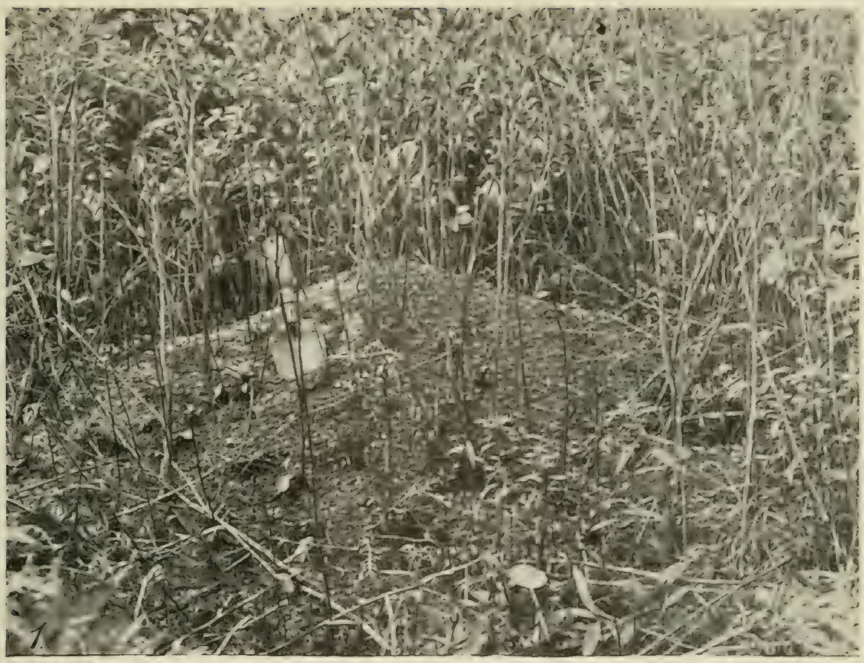


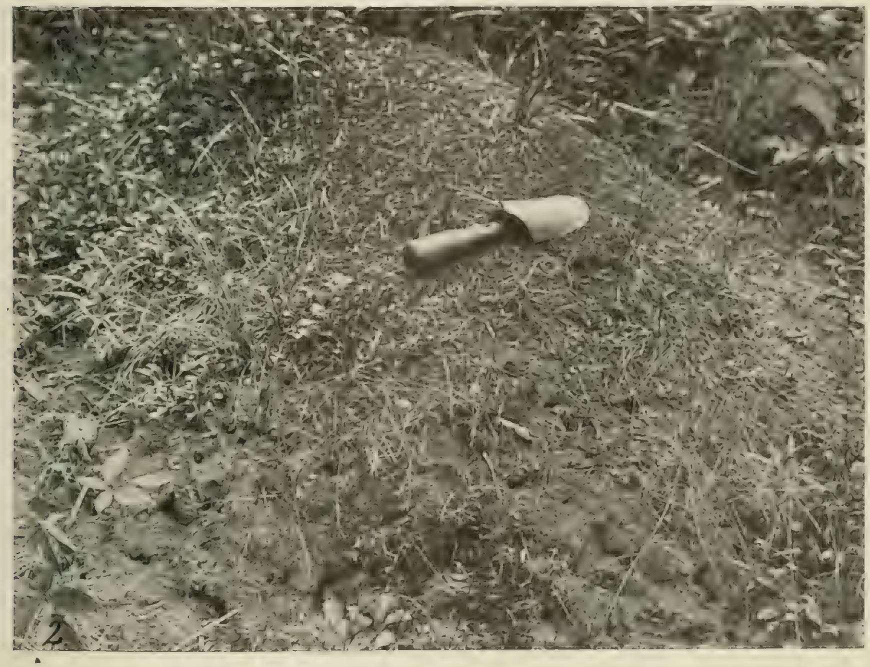
SMALL NESTS OF FORMICA EXSECTOIDES.





LARGE NESTS OF FORMICA EXSECTOIDES.





LARGE NESTS OF FORMICA EXSECTOIDES.

59.57.2(729.6)

Article V.—THE ORTHOPTERA OF THE BAHAMAS.

By James A. G. Rehn,

Of the Academy of Natural Sciences of Philadelphia.

The present paper on the orthopterous fauna of the Bahamas is based in by far the greater part on two collections; one belonging to the American Museum of Natural History, and the other to Mr. Morgan Hebard of Chestnut Hill, Philadelphia. As far as can be ascertained but five previous papers on, or records of Bahaman Orthoptera have been published, one, the most exhaustive, by Morse, two by Scudder, and two by the author, and these have been mentioned in their proper position to make the paper as complete as possible. With these records the total number of determined species is thirty-three, eight of which are only in American Museum series, five in the Hebard collection, and five in both. Morse treated of eleven species not previously recorded or studied in this connection, six being new. A tabulation of the species here treated to ascertain the possible relationship of the orthopterous fauna of the Bahamas presents the following data:

Four species very broadly and generally distributed through North and South America as well as the West Indies.

One species otherwise known only from the United States.

One species otherwise known only from the whole eastern United States and Cuba.

Eleven species known from the Gulf region of the United States or Florida and Georgia alone, and the West Indies.

Eight species West Indian.

Eight species (two new) peculiar to the Bahamas.

Thus from such information as is at hand it would appear that the Orthoptera of these Islands, as a whole, are as closely related to the mainland fauna, and particularly that of southern Florida, as to that of the West Indies. However, the evidence in hand is so unsatisfactory that no conclusions, can be reached, and more localities and more islands must be examined and thorough collections made before we can say with any certainty whence the principal elements of the orthopterous fauna came. While it is hardly likely that the Bahamas will prove to be the home of as many species of the order as Cuba, the variety of conditions in the latter island being probably responsible for the richness of the insect fauna, still it is very probable that we know not more than a fourth of the species inhabiting the Bahamas.

Mr. Hebard has kindly furnished the following note on his collecting in the vicinity of Nassau, New Providence: "During my four-day stay in Nassau (January 31 to February 4, 1904) the weather was very cool for that region, the temperature not exceeding 73° at noon on any day, and a constant high wind made collecting difficult. Along the shore and in the open fields there were several species of Orthoptera to be found, and under stones and the bark of dead trees the species inhabiting such places were quite plentiful. In the negro village (Grant Town) in the interior of the island the vegetation is far more tropical than on the shore, and I found fairly good collecting along the lanes. The almost impenetrable scrub which covers the greater part of the island proved almost without Orthoptera, as were also the large marshes in the interior, but in the fall these places may prove very different collecting grounds. In February the best collecting could be done about Fort Charlotte. Hog Island, in the harbor, is low and sandy, and covered with a vegetation similar to that on New Providence Island. Considering the scarcity of grasses I was surprised to find, with but little searching, quite a few specimens of *Chortophaga cubensis* and *Schistocerca*."

Field notes contributed by Mr. Hebard are indicated through the paper by (H.)

The material belonging to the American Museum was collected by Dr. Wm. M. Wheeler while on a trip made in the spring and early summer of 1904 and was in the greater part from the island of Andros and adjacent keys.

The author wishes to thank Mr. William Beutenmüller, Curator of Entomology of the American Museum, and Mr. Hebard for the opportunity to study the material here treated.

LITERATURE.

MORSE, A. P. Some Bahama Orthoptera. *Psyche*, XII, p. 19–24, 1905.

Twenty-six species recorded, six described as new, some doubtfully recorded on immature individuals.

REHN, J. A. G. Notes on West Indian Orthoptera, with a List of the Species known from the Island of Porto Rico. *Trans. Amer. Ent. Soc.*, XXIX, pp. 129–136, 1903.

Records *Leucophæa maderæ* from the Bahamas.

REHN, J. A. G. Studies in American Blattidæ. *Trans. Amer. Ent. Soc.*, XXIX, pp. 259–290, 1903.

Records *Hemiblabera brunneri* from Nassau.

Scudder, S. H. The Orthopteran Genus Schistocerca. *Proc. Amer. Acad. Arts and Sci.*, XXXIV, No. 17, pp. 441–476, 1899.

Records *Schistocerca alutacea* (*rubiginosa*) and *americana* from Inagua, Bahamas.

Forficulidæ.

Labidura bidens (*Olivier*).—Nassau, February 3, 1904 (Hebard), one inmature female "Taken from under coquina stones near Fort Charlotte." (H.) Menendez Sisal Plantation, Stanley, New Providence, June 26, 1904 (Wheeler), one female, two immature individuals.

Anisolabis annulipes (*H. Lucas*).—Nassau, February 3, 1904, (Hebard), twenty specimens representing both sexes; May-June, 1904 (Wheeler), two females, one immature individual. "Any number of specimens of this species might have been taken from a crumbling coquina wall of Fort Charlotte. Many were also taken from under coquina boulders strewn about near the fort." (H.) Grant Town, New Providence, February 3, 1904 (Hebard), one male. Little Golding Key, Andros, June 10, 1904, (Wheeler), one female.

These specimens exhibit considerable variation in size as well as in the intensity of the blackish femoral annuli. There is also a great variation in the position of the pale distal annulus of the antennæ, as in some the eleventh and twelfth joints are involved, in others the position is apical and on the sixteenth and seventeenth, and in others the intermediate joints bear it; in some but one joint is pale, two is the usual number and in others no annuli are present.

From present evidence *A. azteca* Dohrn appears to be doubtfully distinct.

Blattidæ.

Blattella punctulata (*Beauvois*).

1805. *Blatta punctulata* Beauvois, Ins. Rec. Afriq. et Amer., p. 184, pl. *ib*, (Orthopt.), fig. 8. [San Domingo.]

1857. *Blatta* (*Phyllodromia*) *delicatula* Guérin in La Sagra, Hist. Phys. Polit. et Nat. l'Ile de Cuba, Anim. Art., p. 346. [Cuba.]

Key No. 1, Crawl Creek, Andros, May 20, 1904 (Wheeler), one female.

There appears to be no reason why Beauvois's name should not be applied to this insect, as the figure clearly represents it. The large size of the figure (no mention is made of the size in the description) is explained in the prefatory note of the author, who informs us there that all the specimens were drawn an inch long, lines giving the natural size being placed alongside of the figures of enlarged species. These seem to have been accidentally omitted from the whole of plate *ib*, and the figure is unmistakably this species.

Blattella adspersicollis (*Stål*).[1]

1860. *Blatta adspersicollis* Stål, Kongl. Svenska Fregatten Eugenies Resa, Ins., p. 308. [Rio Janeiro.]

Bahamas [U. S. Nat. Mus.], one female. This individual is somewhat smaller than Florida specimens.

The relationship of this species to others of this difficult section of the genus is poorly understood. The species *vitrea*, *dilatata*, *zapoteca*, *pavida*, and *adspersicollis* are very closely related and, to say the least, not easy to separate.

Ceratinoptera diaphana (*Fabricius*).—Pot Key, Andros, May 19, 1904 (Wheeler), one immature female. While immature this specimen is so characteristically marked that it can be referred here with very little doubt.

Ischnoptera blattoides (*Saussure*).

1863. *Epilampra blattoides* Saussure, Melanges Orthopterologiques, fasc. I, p. 17. [The East Indies; Bombay.]

Nassau, February 3, 1904 (Hebard), one male, two females. Fish Hawk Key, Andros, May 19, 1904 (Wheeler), one female. Mangrove Key, Andros, May 25, 1904 (Wheeler), one male. Recorded by Morse (p. 19) from Mangrove Key.

Epilampra, sp. — Nassau, May–June, 1904 (Wheeler), one immature individual.

Eurycotis, sp. — Recorded by Morse (p. 19) from Mangrove Key, Andros. Possibly this record may refer to the following species.

Eurycotis bahamensis, sp. nov.

Types ♂ and ♀ ; Fish Hawk Key, Andros (♂); Little Golding Key, Andros (♀); May 19 (♂), June 19, 1904 (♀). (Wheeler.) [Amer. Mus. Nat. Hist.]

Size medium; form subovate, somewhat depressed. Head very nearly hidden by the pronotum; interspace between the eyes very broad and equal to that between the antennal scrobes; antennæ slender, exceeding the body in length in the male and apparently slightly shorter in the female. Pronotum with the caudal width but little less than twice length, the transversely arcuate; cephalic margin with a very slight median emargination, rounding into the rather oblique, slightly arcuate lateral margins, caudo-lateral angles subrectangulate, caudal margin subtruncate. Mesonotum slightly more than half the length of the pronotum, caudal margin subtruncate. Tegmina squamiform, lateral, very slightly or not at all exceeding the mesonotum in length, the length about half

---

[1] This is the species recorded by me as *B. punctulata*, from Porto Rico (Trans. Amer. Ent. Soc. XXIX, p. 130) and *B. azteca* from Porto Rico and Jamaica (*Ibid.*, XXIX, p. 268). The change in the name in the first mentioned record is due to a different understanding of Beauvois's name *punctulata*.

again the proximal width, internal margins oblique, the tegmen thus being somewhat tapering, apex bluntly rounded ; surface coriaceous. Metanotum slightly shorter than the mesonotum, but structurally similar. Abdomen very slightly broader (at its greatest width) than the thoracic width, all segments somewhat, but the caudal segments considerably, produced at the caudo-lateral angles. Supra-anal plate of the male transverse, the lateral margins considerably oblique, apical margin with a broad and very shallow emargination, cercal emarginations distinct; supra-anal plate of the female tectate, produced, apex with a considerable and well marked trigonal emargination. Cerci of the male considerably exceeding the supra-anal plate, depressed, moderately acute; cerci of the female slightly longer than the supra-anal plate, otherwise as in the male. Subgenital plate of the male narrow, strongly transverse, the apical margin arcuate, sinuate laterad and provided with a pair of acute styles slightly longer than the plate; subgenital plate of the male trigonal, the division of the valves being along a tectate ridge. All the femora supplied on the ventro-cephalic margin with spines, the cephalic having a very considerable series; tibiæ with three dorsal rows of spines; caudal metatarsus about as long as the remaining joints of the tarsus united; arolia present.

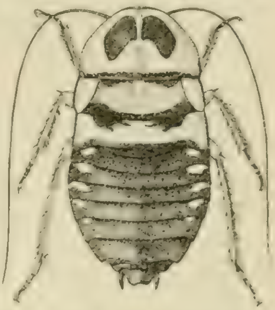


Fig. 1.—*Eurycotis bahamensis*, sp. nov. Male (type). 1½ nat. size.

General color of the head, pronotum, mesonotum, tegmina, metanotum, coxæ, and femora ochre yellow, more included toward ochraceous-rufous dorsad than ventrad. Head with the eyes, a broad bar between them, another between the antennæ and another transverse one just above the clypeal margin blackish; antennæ blackish brown proximad become paler and more ochraceous distad. Pronotum very narrowly margined with blackish cephalad and laterad, rather broadly caudad, in the middle of the disk bearing a paired blackish maculation resembling spectacles. Mesonotum and metanotum rather broadly margined caudad with blackish, marked cephalad with the same but the markings only apparent as lateral sub-trigonal maculations. Tegmina laterad and the lateral margins of the metanotum narrowly margined with black. Abdomen blackish dorsad and ventrad, all the segments except several apical ones bearing lateral maculations of the general thoracic color. Tibiæ and tarsi dark reddish brown, the caudal pair darker than the others.

Measurements.

	♂	♀
Length of body,	24.5 mm.	29.5 mm.
Length of pronotum,	7. "	9. "
Caudal width of pronotum,	11. "	13. "
Length of tegmen,	3.5 "	5.2 "

An additional female from Little Golding Key has also been examined.

Allied to *E. flavipennis* Saussure and Zehntner,[1] but differing in the much greater size and the quite different coloration of the head, pronotum, meso– and metanotum. Bolivar's *E. dimidiata*[1] is also a close relative of this species, but no mention is made in the description of the spectacle-like markings on the pronotum of the Bahaman individuals.

---

[1] Biol. Cent.-Amer., Orth., I, p. 71, 1893. [Cuba.]

Periplaneta americana (*Linnæus*).—Andros, May–June (Wheeler). Recorded by Morse (p. 19), from New Providence and Mangrove Key, Andros.

Periplaneta australasiæ (*Fabricius*).—Nassau, February 3, 1904, (Hebard), one immature female. Grant Town, New Providence, February 3, 1904 (Hebard), two males, three females. "Taken from the paper lined walls of the negro huts, where this species was to be found by the thousand." (H.) Andros, May, and June (Wheeler). Recorded by Morse (p. 19), from New Providence and Mangrove Key.

Leucophæa maderæ (*Fabricius*).—Grant Town, New Providence, February 3, 1904 (Hebard), one male, one immature individual. "While searching through the paper covered walls of a negro hut for *Periplaneta* I disclosed the male specimen, which made violent efforts to escape." (H.)

This species has been previously recorded from the Bahamas, without definite locality, by the author (Trans. Amer. Ent. Soc., XXIX, p. 131, 1903), and by Morse (p. 19) in the same way.

Pycnoscelus surinamensis (*Linnæus*).—Nassau, February 3, 1904 (Hebard), one immature individual; May–June, 1904 (Wheeler), one immature specimen; June 20, 1904 (Wheeler), seven immature specimens. Grant Town, New Providence, February 3, 1904 (Hebard), two females, five immature specimens. "Everywhere this species appears to be equally plentiful and is always to be found under stones and loose trash." (H.) Nickells Town, Andros, May 14, 1904 (Wheeler), one immature specimen. Recorded by Morse (p. 19) from New Providence.

Hemiblabera brunneri (*Saussure*).—This species has previously been recorded from Nassau by the author (Trans. Amer. Ent. Soc., XXIX, p. 290, 1903). The species were originally recorded from Porto Rico.

Hemiblabera sp. indet.—Recorded by Morse (p. 19) from Mangrove Key, Andros, and possibly the preceding species.

---

[1] Mém. Soc. Zool. France, I, p. 125. [Guantanamo, Cuba.]

Aphlebia inusitata, sp. nov.

Type ♂; Andros Island, Bahamas, May–June, 1904. (W. M. Wheeler.) [Amer. Mus. Nat. Hist.]

Size, very small; form, considerably depressed. Head hidden under the pronotum, vertex very broad, antennæ moderately hirsute. Pronotum rounded; cephalic and lateral margins rather evenly arcuate, caudal margins slightly emarginate, lateral angles rectangulate. Tegmina corneous, slightly longer than the pronotum and reaching very slightly beyond the middle of the abdomen, overlapping for about two-thirds their length; costal margin slightly arcuate, sutural margin nearly straight, distal margin obliquely truncate; no veins present, costal margin considerably reflexed. Wings not functional. Abdomen tapering; supra-anal plate strongly truncate, roundly and slightly produced mesad, slightly tectate; cerci not quite twice the greatest length of the supra-anal plate, depressed, rather blunt. Femora with both ventral margins armed with fine, closely placed spines.

General color raw sienna; head washed with dark brown, eyes blackish; pronotum with the supra-cephalic section dark; abdomen with the segments dark proximad; limbs pale ochraceous.

Measurements.

Length of body,	4.6 mm.
Length of pronotum,	1.5 "
Length of tegmen,	2. "

The type is the only specimen seen.

This very peculiar species appears to belong to this Old World genus, but is not closely related to any of the species placed in *Aphlebia*, all Eurasian and African, and may constitute a distinct genus, which, however, would be closely related to *Hololampra*. The presence of series of closely placed spines on both ventral margins of the femora is one of the most distinctive characters.

[The interesting Blattid here described by Mr. J. A. G. Rehn was taken from the galleries of a large nest of a jumping ant (*Odontomachus hæmatodes insularis* Guérin var. *pallens* Wheeler). It is in all probability a myrmecophile.—W. M. Wheeler.]

PHASMIDÆ.

Malacomorpha,[1] gen. nov.

A member of the Anisomorphinæ and allied to *Agathemera* and *Autolyca* Stål, but differing in the carinate limbs, the granulose and rugose body, and a number of other characters.

Apterous; surface bluntly tuberculate; limbs carinate; areolate space present on the distal portion of the tibiæ; abdominal segments subequal in length, the proximal transverse. Median segment slightly longitudinal. Tarsal joints all provided with pulvillæ and large arolia present. Subgenital opercule short; cerci short, subequal, blunt.

---

[1] Μαλακος, *feeble*, μορφη, *form*.

Type.—*M. androsensis*, n. sp.

Malacomorpha androsensis, sp. nov.

Type: ♀; Key No. 4, North Side of South Bight, Andros, May 23, 1904, (Wheeler). [A. M. N. H.] Size small; form moderately robust. Head slightly depressed; eyes subovate, laterad, quite prominent, but slightly flattened, when viewed dorsad; ocelli minute, disposed in a triangle with the base cephalad and placed between the eyes; occiput with six longitudinal lines of small tubercles; antennæ about as long as the head and thorax together, rather robust, the two proximal joints depressed, the second smaller than the first, third cylindrical and slightly longer than either the first or second, succeeding joints increasing in length with moderate regularity. Pronotum as long as the head, subquadrate but slightly constricted cephalad; lateral margins elevated, cephalic and caudal margins subtruncate; median cruciform depression distinct, the transverse arm slightly cephalad of the middle. Mesonotum nearly half again as long as the pronotum, slightly broader caudad than cephalad, the increase in width being regular and continuous with that of the pronotum, a fine longitudinal median depression present in continuation of that of the pronotum. Metanotum very slightly longer than the mesonotum, median longitudinal impressed line continued from the mesonotum; median segment subquadrate, slightly longer than the remainder of the metanotum. Abdomen slightly flattened ventrad, arched dorsad, tapering but robust and not slender, five proximal segments more or less transverse, sixth subquadrate, seventh and eighth very slightly transverse; a median impressed area in continuation of the impressed thoracic line, bounded laterad by blunt carinæ is distinct on the proximal segments, becoming lost on the seventh, and replaced on that and the eighth segment by a blunt apical tubercle; ninth dorsal segment slightly longitudinal with the caudal margin rounded and with the apex truncate; supra-anal plate with the blunt obtuse-angulate apex just visible; cerci short, simple, nearly straight with the distal portions very blunt; subgenital opercule shallow, small, hardly reaching the caudal margin of the eighth dorsal segment, caudal margin rounded with the immediate apex blunt. Limbs short and comparatively robust, all the tibiæ with large distal arolia, and both femora and tibiæ strongly carinate; metatarsi not exceeding the three succeeding tarsal joints in length; arolia between the tarsal claws large. Cephalic femora about as long as the head and pronotum together, tibiæ slightly shorter. Median femora distinctly shorter than the cephalic. Caudal femora but slightly shorter than the pro- and mesonotum together, and when laid back alongside the abdomen reaching to the caudal margin of the fourth segment.

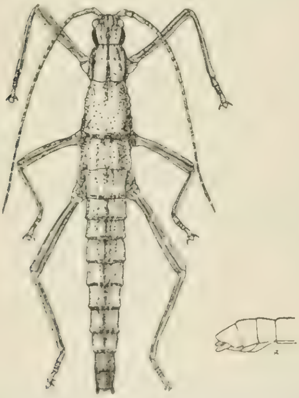


Fig. 2.—*Malacomorpha androsensis*, gen. et sp. nov. Male (type). 1½ nat. size. *a*, side view of last four abdominal segments.

General colors isabella-color and drab with a little bistre. The basic shade is isabelline overlaid by drab in an indescribable series of broken lines, washes, and patches, a median line of bistre divided by a rather broken thread-like longitudinal line of the pale color is quite apparent, the sides of the head and pronotum are much suffused with bistre, and the whole abdomen is darker than the thorax. . Antennæ of the two base colors, imperfectly annulate.

Measurements.

Length of body,	32	mm.
Length of pronotum,	3.7	"
Length of mesonotum,	5.	"
Length of metanotum (with median segment),	6.	"
Length of abdomen,	17.	"
Length of cephalic femur,	7.	"
Length of median femur,	5.5	"
Length of caudal femur,	7.8	"

The type is the only specimen seen of this striking and extremely interesting genus.

ACRIDIDÆ.

Amblytropidia.—One nymph recorded by Morse (p. 19) from Stranger Key was questionably referred to this genus by him.

Orphulella olivacea (*Morse*).

1893. *Stenobothrus olivaceus* MORSE, Psyche, VI, p. 477. figs. 1 and 2. [Greenwich and Stamford, Connecticut.]

Recorded by Morse (p. 19) on one male from Stranger Key.

Orphulella pelinda (*Burmeister*)?

1838. [*Gomphocerus*] *peludius* BURMEISTER, Handb. d. Entm., II. Abth. II, pt. i, p. 650. [Pennsylvania.]

Nassau, January 31, 1904 (Hebard), two males, two females. "This species was found quite abundant in the salt-grass along the shore. The specimens were all highly colored, and so active that time was found to capture only a few." (H.) Hog Island, near Nassau, February 4, 1904 (Hebard), one immature individual. These specimens are referred to this species with some doubt, as the status of the name is, in the author's opinion, open to some question.

Chortophaga cubensis (Scudder).

1875. [*Tragocephala*] *cubensis* SCUDDER, Proc. Boston Soc. Nat., XVII, p. 483. [Cuba; La Firmina, near Bemba, Cuba.]

Nassau, January 31, 1904 (Hebard), three males, one female. Hog Island, near Nassau, February 4, 1904 (Hebard), one female.

The records of this hitherto peculiarly Cuban species are of considerable interest.

Schistocerca alutacea (*Harris*).—This species has been recorded as

S. rubiginosa, by Scudder from Inagua, Bahamas (Proc. Amer. Acad. Arts and Sci., XXXIV, pp. 462–463, 1899).

Schistocerca americana (*Drury*).—This species has been recorded by Scudder from Inagua, Bahamas (Proc. Amer. Acad. Arts and Sci., XXXIV, pp. 474, 475, 1899), and by Morse (p. 19) from Nassau, Elbow Key, Mangrove Key, Andros, and Stranger Key. Nymphs of species of this genus were also recorded by Morse (p. 19) from Nassau, Mangrove Key, and Stranger Key. Andros, May and June. (Wheeler.)

Paroxya dissimilis (*Morse.*)

1905. *Paroxya dissimilis* MORSE, Psyche, XII, p. 20. [Mangrove Key, Andros.]

Described by Morse from a pair from the type locality. The species is related to *P. atlantica* of the mainland.

Paroyxa sp.—Immature individuals from Stranger Key were assigned to this genus by Morse (p. 20).

TETTIGONIDÆ.

Conocephalus nieti *Saussure.*

1859. *Conocephalus nieti* SAUSSURE, Revue et Magasin de Zoologie, 2e ser., XI, p. 208. [Mexico.]

Recorded from Nassau by Morse (p. 20).

Conocephalus sp.—Immature individuals of a species with acuminate vertex from Nassau were recorded by Morse (p. 20).

Xiphidion fasciatum (*De Geer*).—Recorded from Nassau by Morse (p. 20).

Xiphidion insulare *Morse.*

1905. *Xiphidion insulare* MORSE, Psyche, XII, p. 20. [Stranger Key.]

Described by Morse from one adult male. Immature specimens, referred by him to this genus, were recorded from Nassau and Mangrove Key.

Xiphidion brevipenne *Scudder.*

1862. *X[iphidium] brevipenne* SCUDDER, Boston Journ. Nat. Hist., VII, p. 451 [Massachusetts; Cape Cod; Maine.]

Nassau, January 31, 1904 (Hebard), two males, two females. "This species was very abundant in the salt-grass along the shore and any number of specimens might easily have been taken." (H.)

GRYLLIDÆ.

Nemobius alleni *Morse.*

1905. *Nemobius alleni* MORSE, Psyche, XII, p. 21. [Moraine Key.]

Described by Morse from four mature specimens and seven nymphs.

Nemobius sp.—One immature male from Nassau was recorded by Morse (p. 21).

Gryllus bryanti *Morse.*

1905. *Gryllus bryanti* Morse, Psyche, XII, p. 22. [Mangrove Key, Andros.]

Described from one female specimen. Apparently allied to *G. firmus.*

Gryllus assimilis *Fabricius.*—Grant Town, New Providence, February 3, 1904 (Hebard), one male, two females. "These specimens were easily captured under coquina blocks among weeds." (H.)

Gryllodes poeyi *Saussure.*

1874. *Gryllodes poeyi* Saussure, Miss. Scientif. Mex., Zool., VI part., p. 420. [Cuba.]

Nassau, January 31 and February 3, 1904 (Hebard), twenty males, ten females, sixteen immature individuals. "On February 3d I visited a cow-shed on the Nassau golf-course near Fort Charlotte, as I had heard the stridulating of many crickets there on the previous day. I found that the ceiling of the shed above the trough had wide cracks in it, which were covered at the end by other wide boards. The grooves thus formed were the homes of countless *Gryllodes poeyi*, and by inserting a straw the inmates would tumble out of the opposite end in a stream. The majority were immature, and many of the mature individuals were injured, but many good specimens were taken. The noise in the shed was continuous, and louder than that of any species of *Gryllus.* The stridulation is constant or steadily jerky, and is pitched to a key of particular shrillness. The insect being wholly nocturnal, moves about but little in the light, and when alarmed jumps in any direction with the utmost speed. The bran in the trough must have proved most enticing food for these insects for the colony was unusually large." (H.)

This species, which has become almost cosmopolitan in the tropics, is apparently as abundant in the Bahamas as in Cuba. The series examined shows but little variation in color and size.

Liphoplus krugii *Saussure.*

1897. *Liphoplus krugii*, Saussure, Biol. Cent. Amer., Orth., I, p. 232. [Cuba.]

Mangrove Key, Andros, one female. Pot Key, Andros, May 19, 1904 (Wheeler), two females.

This species has previously been recorded from Cuba and southern Florida.

Cycloptilum americanum *Saussure.*

1874. *Cycloptilum americanum* SAUSSURE, Miss. Scient. Mex., Orth., p. 426. [Cuba.]

A pair from Nassau were recorded by Morse (p. 21).

Mogoplistes barbouri *Morse.*

1905. *Mogisoplistus barbouri* MORSE, Psyche, XII, p. 21. [Nassau, New Providence.]

Based on one female specimen.

Cyrtoxipha sp. indet.—Morse (p. 23) records one badly damaged female of this genus from Nassau.

Amphiacusta bahamensis *Morse.*

1905. *Amphiacustes bahamensis* MORSE, Psyche, XII, p. 23. [Mangrove Key, Andros.]

Based on three adult males and one female, and four nymphs, all from the type locality.

Amphiacusta annulipes *Serville.*

1831. *Phalangopsis annulipes* SERVILLE, Ann. Sci. Nat., XXII, p. 167. [Port-au-Prince, Haiti.]

Nassau, January 31, 1904 (Hebard), one immature specimen. Mangrove Key, Andros, June 12, 1904 (Wheeler), one female. Recorded by Morse (p. 23) from Nassau.

Orocharis gryllodes *Pallas.*

1772. *Gryllus gryllodes* PALLAS, Spicilegia Zoologica, I, fasc. 9, p. 16, tab. i, fig. 10. [Jamaica.]

Nassau, May–June, 1904 (Wheeler), one female. Andros, May–June, 1904 (Wheeler), one immature female.

These specimens are shrivelled, and as far as can be determined in their condition are identical with Florida specimens of *gryllodes*.

Tafalisca lurida *Walker.*

1869. *Tafalisca lurida* WALKER, Catal. Spec. Derm. Salt. Brit. Mus., p. 53. [St. Domingo.]

Little Golding Key, Andros, June 19, 1904 (Wheeler), one male. Mangrove Key, Andros, June 12, 1904 (Wheeler), one immature specimen. Dog Key, North of Andros, May 13, 1904 (Wheeler), one immature specimen.

The mature specimen agrees with Florida individuals.

59.51,78(52)

Article VI. — THE MYZOSTOMES OF THE 'ALBATROSS' EXPEDITION TO JAPAN.

By J. F. McClendon.

Plates XV–XVII.

In the spring of 1903, Dr. W. M. Wheeler, under whom I was working at the University of Texas, gave me some Myzostomes to work over, consisting of two lots: first, a vial of Myzostomes from Pacific Grove, Cal., collected by Dr. Bashford Dean, and second, the Myzostomes taken by Dr. Hubert Lyman Clark from Crinoids and Ophiurans dredged by U. S. S. 'Albatross' off the eastern coast of Japan in the spring of 1900. I turned over the unfinished work to Dr. Wheeler, but when I saw him in June, 1905, he asked me to complete it. The material is now in the collection of the American Museum of Natural History, New York. Through the kindness of Honorable George M. Bowers, U. S. Commissioner of Fish and Fisheries, Dr. Hugh M. Smith, Director of Scientific Inquiry, and Miss M. J. Rathbun of the Smithsonian Institution, I was allowed to examine the remainder of the Crinoids dredged by the 'Albatross' off Japan, consisting of a large number of specimens of *Metacrinus rotundus*(?). Twelve of these were infested with *Myzostoma metacrini* n. sp., and two of the twelve also with *M. clarki* n. sp. The California material was fixed in formalin and the Japanese in alcohol, but except for the shrinkage of some large eggs floating in the body cavity and the partial destruction of the cilia in the enteric canal, the finer structure of the specimens seemed fairly well preserved.

Before speaking of the morphology of these animals, I should say that throughout this paper I call the central part of the alimentary canal, between the pharynx and rectum, the *stomach;* and the cœca that arise from it, *intestinal diverticula* and *ramifications;* the cells that attach to the egg, *accessory cells;* and the segmentally arranged sacs on the ventral side, *suckers;* although they may have been called by other names by well-known workers on the subject. If we regard *Myzostoma* as a segmented animal, the suckers are placed midway between the parapodia in all the species I have examined, and when I say that the suckers are "midway" between the parapodia and the edge of the disc, I do not mean that the suckers are in line with the parapodia.

After the work of Wheeler (1897), von Stummer-Traunfels (1903), and earlier workers, what I have to say on the general internal morphology may be expressed in few words. The ovaries are not constant in position, but in all the species examined lie very near the wall of the stomach. As the animal increases in size, the mesoderm breaks down in large spaces, which become filled with growing eggs (primary oöcytes). With this disappearance of the mesenchyme, parts of the testes are isolated, thus cutting off the direct path of exit of the spermatozoa which are found wandering through the enlarged body cavity and even between cells of the ovary (previously observed by Wheeler), and probably some pass out through the uterus.

Dr. H. L. Clark says that *Metacrinus* infested with cysticolate myzostomes is not infested with ectoparasitic species, and *vice versa*, but I found a specimen of *M. metacrini* on each of the two crinoids on which I found a cyst of *M. clarki.*

In the cyst of *Myzostoma cysticolum* the small individual may take the place of the large one when the latter dies; at any rate, it could not get out through one of the pores. The small individual I sectioned did not function as "complemental male," for it contained no mature spermatozoa. It may have developed from one of the eggs of the large individual and utilized the narrow space left in the cyst as a convenient hiding place till it was too large to get out.

ENDOPARASITIC (CYSTICOLATE) SPECIES.

1. **Myzostoma cysticolum** *von Graff*, Challenger Reports, X, Myzostomida, p. 66, pl. xiii.

Von Graff found specimens in cysts in the arms of *Actinometra meridionalis*, dredged by U. S. S. 'Hassler' off Cape Frio, Brazil, January 22, 1872, and by U. S. S. 'Blake' during the winter of 1878–1879, at Station 249, off Grenada, West Indies. I have only one cyst, formed in the arm of *Antedon discoidea* P. H. C., dredged by U. S. S. 'Albatross' off the eastern coast of Japan, in the spring of 1900. It is larger than any of von Graff's specimens, being 5 mm. in length, while none of his was over 3 mm. in length, and shows slight morphological differences. For these reasons, and because they were found in different hosts and in different hemispheres, I consider them as distinct varieties.

Myzostoma cysticolum var. **orientale** var. nov.

(Pl. XVI, Figs. 14, 15; Pl. XVII, Figs. 19, 26.)

One cyst in arm of *Antedon discoidea* P. H. C. Cyst 5 mm. in length with a pore at each end (unlike cysts of von Graff's specimens, which had only one pore in each), containing two individuals very light brown in color, viz.: a large one occupying nearly all of the cavity of the cyst, and a small flat one, between the large one and the wall, near one of the pores.

Small individual (Pl. XVI, Fig. 14, and Pl. XVII, Fig. 26): Length 1.1 mm. Nearly circular in outline, a little longer than broad, very thin, and slightly concave: on the dorsal side. Mouth and anus opening into notches at fore and hind edges of the disc. Parapodia and hook apparatus well developed. Parapodia about midway between center and edge of disc, which is nearer the center than in von Graff's figure. Suckers and cirri absent. There are three intestinal diverticula on each side, which subdivide but do not extend to the edge of the disc. Testes well developed (but no mature spermatozoa) and opening by very short ejaculatory ducts at edges of the disc midway between the mouth and cloacal aperture. There are two pairs of small ovaries latero-ventral to stomach; no eggs.

Large individual (Pl .XVI, Fig. 15, and Pl. XVII, Fig. 19): Length 4.2 mm. Differs from small individual in being much more robust, having the anterior and posterior ends more deeply notched and the body folded so that the two halves of the dorsal surface approach each other, leaving a cavity in which, according to von Graff, the eggs develop. The parapodia are vestigial. The mesenchyme, too, has nearly disappeared, being represented only by a few strands, while the vacated space is filled with growing eggs, some of which have begun to crowd into the uterus. The two pairs of ovaries have grown, and by the folding of the body have been brought nearer the intestine. Von Graff figures a section of a cyst, cutting both individuals, and shows testes in the large individual in the position in which I found ovaries. But I am sure I am not mistaken, for the distal end of the ovary, when examined with high magnification (Zeiss Apochromat. imm. ob. 1.5 mm., oc. 12) is seen to contain oöcytes, each with two accessory cells having darkly staining nuclei, an appearance never seen in the testes. In many Myzostomes spermatozoa wander through the ovaries (Wheeler) and are very misleading. No testes were found.

2. **Myzostoma clarki**[1] sp. nov.

(Pl. XV, Figs. 7-10, and Pl. XVII, Figs. 17, 29.)

Seven cysts formed by enlargements of arms of *Metacrinus rotundus* Carp., dredged by U. S. S. 'Albatross,' Suruga Gulf and Sagami Sea, Japan, 1900, each containing a solitary individual. The cysts vary from 6 to 10 mm. in length. Each cyst is an oval enlargement on the ventral side of the arm, with a pore at each end. The animal is very light brown in color. It differs from *M. cryptopodium* Wheeler in having the parapodia only partially pressed into the body, and not entirely hidden in grooves, as in the latter. The specimens examined ranged from 4.5 to 7.3 mm. in length. The body is very robust and the lateral margins are curled dorsally, while the concave dorsal surface is wrinkled longitudinally. It lies in the cyst with its mouth near one pore and its cloacal opening near the other. There is a pair of vestigial cirri at each end. The parapodia decrease in size from before backward. Hooks are well developed. The suckers have very small necks (Pl. XVII, Fig. 17, *s*). The mouth and cloacal orifice are minute; the former is at the anterior end, the latter in a notch at the posterior end. The pharynx extends backward nearly to the middle of the body. There are three pairs of intestinal ramifications, which subdivide. The mesenchyme wastes away as the animal grows, and becomes filled with eggs. There are two pairs of ovaries on diagonal strands connecting the bases of the internal diverticula with the ventral wall of the body. I sectioned specimens measuring 4.5, 5, 6.5, and 7.3 mm. in length and found ovaries in all of them, but no testes. It is probable that they are hermaphroditic, but that all the specimens were so old (large) that the testes had disappeared. In the smallest, young eggs were found in the body cavity, and in the others the number and size of these increased with the size of the individual. In the largest specimen eggs were being produced very rapidly. Masses of a hundred or more very small oöcytes were detached from the ovary and distributed through the body cavity. The nuclei of the accessory cells could be distinguished in the eggs after they had reached a considerable size (Pl. XVII, Fig. 29), but large numbers of them were floating free or surrounded by a thin film of cytoplasm, in the body cavity.

---

[1] Named after Dr Hubert Lyman Clark.

ECTOPARASITIC SPECIES.

3. **Myzostoma metacrini** sp. nov.

(Pl. XV, Fig. II, and Pl. XVII, Fig. 20.)

One specimen with some cirri lost and the body folded, taken by Dr. H. L. Clark from *Metacrinus rotundus* Carp., dredged by U. S. S. 'Albatross,' eastern coast of Japan, 1900.

On looking over the remainder of the above lot of Crinoids, I found seventeen specimens on what I believe to be *Metacrinus rotundus*. These specimens as well as the Crinoids are in the Smithsonian Institution.

Length 2.5 to 6 mm. About one and a half times as long as broad. Flattened, and light greenish brown in color, with a clear margin. Parapodia attached midway between the center and the edge, very extensible and swollen at their bases. The base of each bears a minute cirrus, possibly homologous with a neuropodial cirrus in the Polychæta. Suckers situated a little nearer the edge than the parapodia. Ten pairs of marginal cirri; posterior pair much longer, and anterior pair somewhat longer than those intervening. There is a penis on each side under the base of the median parapodium. The mouth is near the anterior, the cloacal aperture at the posterior end.

In a specimen 5 mm. long, that I sectioned, the stomach and intestinal epithelium was much thicker on the dorsal than on the ventral side. The mesenchyme had nearly all disappeared and the vacated space was filled with eggs. There was a single pair of ovaries, elongate in shape, each attached by one end to the dorso-lateral wall of the stomach. Testicular follicles, probably only remnants of the testes of earlier stages, were distributed chiefly around the intestinal ramifications.

4. **Myzostoma antennatum** *von Graff.*

(Pl. XV, Fig. 5, and Pl. XVII, Figs. 21, 30.)

Myzostoma ambiguum VON GRAFF, Challenger Reports, X, Myzostomida, p. 54, pl. viii; *Ibid.*, XX. Myzostoma Supplement, p. 10, pl. ii.

Von Graff had but one imperfect specimen of *M. antennatum*, from Amoy, host uncertain.

Only one imperfect specimen of *M. ambiguum* found loose in spirit with two species of *Actinometra* and five of *Antedon*, from the Moluccas.

Von Graff distinguishes these two by the length of the ninth pair of cirri, which are longer in *M. ambiguum* than in *M. antennatum;* by a difference in breadth of the clear border; and by the color. I have twenty-four specimens from *Actinometra* sp., and one from *Metacrinus rotundus* Carp., dredged by U. S. S. 'Albatross' in Suruga Gulf and Sagami Sea, Japan, 1900. The one from *Metacrinus* was dark brown, like von Graff's *M. antennatum;* the others bright yellowish brown, like *M. ambiguum;* but in form they showed variations between the two species of von Graff. One may have been darkened by tannin from the cork, or by substances from the Crinoids, and in the absence of morphological distinctions, I do not think the color worth much consideration; in fact, I believe von Graff's two species are synonymous.

The body is a flattened disc, almost circular in some specimens, more or less elongated in others, bordered by a clear area of variable width, into which the intestinal ramifications do not penetrate. There are ten pairs of cirri, of which the first, second, ninth, and tenth are about twice as long as the others. The parapodia are prominent and have well developed hook apparatus. They are inserted about half way between the center and the edge of the disc. Under the bases of the third parapodia there is a pair of penes that may be extended a little beyond the edge of the disc or retracted until scarcely visible. The suckers are elongated in a radial direction, and placed about half way between the bases of the parapodia and the edge of the disc. There is a single pair of ovaries lateral to the stomach (Pl. XVII, Fig. 21). I sectioned specimens 1.6, 2.2, and 3 mm. in length, and they each had one pair of ovaries, eggs in all stages of growth, and testes with mature spermatozoa.

5. **Myzostoma wheeleri** sp. nov.

(Pl. XVI, Fig. 16, and Pl. XVII, Fig. 25.)

Eight specimens on pinnules of *Metacrinus rotundus* Carp., dredged by U. S. S. 'Albatross,' Suruga Gulf and Sagami Sea, Japan, 1900.

Each specimen is about 4 mm. in length and brown in color. The body is stout and its lateral margins are bent downward, probably to grasp the pinnæ, making the dorsal surface very convex and the ventral very concave. In this condition, the body is about four times as long as broad, and its broadest diameter about one-third its length from the anterior end. There are ten pairs of short, slender cirri. The parapodia are well developed but usually partially hidden by the lateral margins of the body. Suckers are absent. The mouth and cloaca open at the ends of the body. The pharynx is slender. There are three pairs of intestinal diverticula which subdivide, and a single pair of elongated ovaries, each attached by one end to the dorso-lateral wall of the stomach. The body cavity contains eggs of various sizes. The testes branch widely in the lateral regions of the body and contain some mature spermatozoa.

6. **Myzostoma deani**[1] sp. nov.

(Pl. XV, Fig. 6, and Pl. XVII, Fig. 27.)

A number of specimens measuring .5 to 1.5 mm. in length, killed in formalin, from *Antedon* sp., dredged off Pacific Grove, Cal., July, 1897, and sent to Dr. Wheeler by Dr. Dean.

---

[1] Named after Dr. Bashford Dean.

Color very light brown. The body is a thick disc, nearly circular in outline; anterior and posterior margins slightly concave. The two halves of the body are bent slightly downward, making in cross-section the dorsal surface convex and the ventral slightly concave. There are ten pairs of very short cirri with swollen bases. The parapodia, which are attached about one-third the radius from the edge of the disc, sometimes extend beyond the edge in small specimens, but do not reach it in large ones. They sometimes enclose the end of the hook and thus become curved at the end. Hook apparatus well developed. Suckers elongated radially, situated about half way between the bases of the parapodia and the edge of the disc. The mouth is on the ventral side very near the anterior end, whereas the cloaca opens at the posterior end. The pharynx is very much retracted (probably due to killing the animal in formalin). The intestinal ramifications do not reach the edge of the disc. The single pair of ovaries is attached to the dorso-lateral walls of the stomach. In a specimen .5 mm. in length the ovaries and testes are small and contain mature spermatozoa, but there are no eggs. In one 1 mm. in length the ovaries and testes are larger, and mature spermatozoa and small eggs are present.

7. **Myzostoma smithi**[1] sp. nov.

(Pl. XVI, Fig. 12, and Pl. XVII, Fig. 18.)

Five specimens from *Antedon discoidea*, dredged by U. S. S. 'Albatross' in Suruga Gulf and Sagami Sea, Japan, 1900.

Length 1.9—3.5 mm. Color brown. The body is flattened, oval in outline, being a little longer than broad. Five pairs of very small cirri. The parapodia are very small, situated midway between the center and the edge of the disc. The hooks are nearly straight. The suckers have irregular stellate mouths about half way between the parapodia and the edge of the disc. The mouth opens below, near the anterior end; the cloaca at the posterior end. The pharynx is stout. There are three pairs of intestinal diverticula which subdivide many times and penetrate almost to the edge of the disc. There is a single pair of ovaries on the dorso-posterior side of the bases of the anterior pair of intestinal diverticula. The testes branch out between the intestinal ramifications. The ejaculatory ducts open at the bases of the median pair of parapodia. A specimen 1.9 mm. in length had ovaries, large testes, small eggs, and a few mature spermatozoa. In another 2.4 mm. in length, the eggs were a little larger, and in specimens 3 and 3.5 mm. long, some eggs had grown to full size and were escaping through the uterus.

---

[1] Named after Dr. Hugh M. Smith.

8. **Myzostoma chelonium** sp. nov.

(Pl. XV, Figs. 1, 2, and Pl. XVII, Figs. 22, 23.)

Twelve specimens from 1.5 to 2.1 mm. in length from *Antedon discoidea* Carp., dredged by U. S. S. 'Albatross' in Suruga Gulf and Sagami Sea, Japan, 1900.

Color yellowish brown. Body robust, nearly circular in outline when seen from above or below. The lateral margins are curled ventrally. The dorsal surface is divided by furrows into polygonal areas giving the appearance of the shell of a turtle in a much more striking manner than *M. testudo* von Graff. The dorsal surface is covered by a thick rough cuticle, honeycombed by perpendicular cavities, in each of which lies a cuticle-secreting cell (Pl. XVII, Figs. 22, 23, *c*). There are ten pairs of short conical cirri on the ventral side near the edge, probably pushed in by the overgrowth of the cuticle. The two anterior and two posterior pairs of cirri are smaller than the others. The parapodia are very large, with swollen bases. Hook apparatus well developed. The suckers are circular. There is a pair of penes under the median parapodia. The mouth and cloaca open below near the anterior and posterior ends of the body, respectively. There are three pairs of intestinal diverticula, which subdivide, and but a single pair of ovaries beneath the bases of the anterior pair of intestinal diverticula. I sectioned specimens 1.5 and 2.1 mm. in length, and found in each, ovaries and testes, with mature spermatozoa and eggs of all sizes.

9. **Myzostoma chelonoidium** sp. nov.

(Pl. XV, Figs. 3, 4, and Pl. XVII, Fig. 24.)

Ten specimens, 1.7 to 2.4 mm. in length, from *Antedon discoidea*, dredged by U. S. S. 'Albatross,' Suruga Gulf and Sagami Sea, Japan, 1900.

If we imagine *M. chelonium* stretched lengthwise until it is over three times as long as broad, we would have a form resembling *M. chelonoidium*. The number of polygons in linear series down the back is one more in the latter, the parapodia are weaker, and the posterior cirri are drawn forward a little.

The animal is yellow in color and of about the shape of *Myzostoma wheeleri*, which is found on the pinnules of the host. I believe that *M. chelonoidium* also is better adapted by its form to cling to pinnules than to the arms or disc. The cuticle is like that of *M. chelonium*, but more regularly honeycombed. There are ten pairs of small cirri attached near the edge, but pushed in from the edge by overgrowth of the cuticle. The anterior pair of cirri is directed forward, the others inward. The parapodia and suckers are small. The mouth and cloaca open on the ventral side near the ends of the body. The stomach is much elongated. There is only a single pair of ovaries which are latero-ventral to the stomach. In both specimens sectioned (1.7 and 2.4 mm. long) I found ovaries, testes, mature spermatozoa, and eggs of all sizes.

10. **Myzostoma japonicum** sp. nov.

(Pl. XVI, Fig. 13, and Pl. XVII, Figs. 28, 31–34.)

Six specimens from *Ophiocreas* sp., eastern coast of Japan, and *Astroceras pergamena* Lyman, dredged by U. S. S. 'Albatross,' Station 3755, eastern coast of Japan, 1900.

Length 1 to 2.5 mm. Color clay yellow. Body flattened, oval, a little longer than broad, flat below and convex above. Ten pairs of very short conical cirri. Parapodia very small, attached about one-third the length of the radius from the edge. Hooks nearly straight and inclined inward, as in *M. smithi*. Suckers absent. Mouth opening below, a little behind the first pair of parapodia. Cloaca opening below near the posterior end. There are three pairs of intestinal diverticula, which subdivide many times but do not penetrate the clear margin of the disc. The ovaries are lateral to the junction of the pharynx and stomach. A specimen 1 mm. in length contained no eggs, others, 1.1 and 1.2 mm. long, contained small eggs, and still others, 1.5, 2, and 2.5 mm. in length, contained eggs of all sizes. All the specimens sectioned contained testes and mature spermatozoa. Plate XVII, Figures 31–34, show successive stages in the transformation of the spermatid into the spermatozoön. In Fig. 31, the nucleus has begun to elongate, the chromatin is in numerous granules. In Fig. 32, the elongation is greater. Fig. 33 shows only a short piece of the elongated nucleus in which the chromatin granules are being united into a single series of discs. Pl. XVII, Fig. 34, shows the discs fully formed. There are over a hundred in number,—more than in *M. glabrum*, which has about twenty-four, and *M. cirriferum*, which has about sixty. The tail has been described by Wheeler for *M. glabrum* and *M. cirriferum* in living specimens, where it is about twice the length of the head. I could trace it a short distance in some sections.

BIBLIOGRAPHY.

1884. Beard, J. On the Life History and Development of the Genus *Myzostoma*. *Mit. Zool. St. Neapel*, V, p. 544, Taf. 31–32.

1894. —— On the Nature of Hermaphroditism in *Myzostoma*. *Zool. Anz.*, XVII, p. 399.

1897. —— The Sexual Conditions of *Myzostoma glabrum*. *Mit. Zool. St. Neapel*, XIII.

1888. Braun, M. Die Myzostomiden. Zusammenfassender Bericht. *Centralbl. Bact. Parasit.*, III.

1804. Carazzi, D. Richerche Embriologiche e Citologiche sull' Uovo di *Myzostoma glabrum*. *Monitoro. Zool. Italiano*, XV.

1884. Carpenter, P. H. On Crinoids of N. Atlantic. (Note by von Graff.) *Proc. R. Soc. Edin.*, XII.

1902. Clark, H. L. New Host for Myzostomes. *Zool. Anz.* XXV, No. 683.

1887. von Graff L. Das Genus *Myzostoma*. Leipzig.

1883. —— Verzeichnis der von 'Hassler' u. 'Blake' ges. Myzostomen. *Bull. Mus. Comp. Zool. Cambridge*, XI.

1884. —— Challenger Reports, X, Myzostomida.

1887. —— Challenger Reports, XX, Myzostomida (Supplement).

1898. von Kostanecki. Die Befruchtung des Eies von *Myzostoma*. *Arch. Mik. Anat.*, LI.

1842. Loven, S. *Myzostoma cirriferum* Leuck., ein parasitischer Wurm. *Arch. f. Naturg.*, VIII, p. 306, Taf. 8.

1895. von Marenzeller. *Myzostoma asteriæ* sp. nova. *Anz. k. Akad. Wiss. Wien*, XVIII.

1866. Metchnikoff, E. Zur Entwicklungsgeschichte von Myzostomum. *Zeit. Wiss. Zool.*, XVI, p. 236, Taf. 13.

1885. Nansen. Bidrag til Myzostomernes Anatomi og Histologi (English Résumé), Bergen, 1885.

1892. Pruho, H. Sur deux Myzostomes parasites de l'*Antedon phalangium* Müller. *Comp. Rend.*, Tome 115, p. 846.

1895. —— Diöicité et Hermaphroditisme chez les Myzostomes. *Zool. Anz.* 1895, No. 486.

1857. Semper, C. Zur Anatomie und Entwicklungsgeschichte der Gattung *Myzostoma*. *Zeit. Wiss. Zool.*, IX, p. 48, Taf. 3 and 4.

1903. von Stummer-Traunfels. Beiträge zur Anatomie und Histologie der Myzostomen, *M. asteriæ*. *Zeit. Wiss. Zool.*, 75.

1887. von Wagner. *Myzostoma bucchichii* n. sp. *Zool. Anz.*, X, No. 225.

1894. Wheeler, W. M. Protandric Hermaphroditism in *Myzostoma*. *Zool. Anz.*, XVII, p. 177.

1895. —— The Behavior of the Centrosomes in the Fertilized Egg of *Myzostoma glabrum* Leuck. *Jour. Morph.*, X, p. 305.

1896. —— The Sexual Phases of *Myzostoma*. *Mit. Zool. St. Neapel*, XII, p. 227, Taf. 10–12.

1898. —— The Maturation, Fecundation, and Early Cleavage of *Myzostoma glabrum* Leuck. *Arch. d. Bio.*, XV.

1899. —— J. Beard on the Sexual Phases of *Myzostoma*. *Zool. Anz.*, XXII.

1905. —— A New *Myzostoma* Parasitic in a Starfish. *Biol. Bull.*, VIII, No 2, Jan. 1905. pp. 75–78, 1 fig.

EXPLANATION OF PLATES.

c — cuticle, surface view.	*od* — uterus.
e — eggs in body cavity.	*s* — sucker (segmental sac).
o — ovary.	*t* — testis.

All the figures except 7, 8, 9, 10, and 17 were drawn with camera lucida with transmitted light. The black ground is merely for contrast.

PLATE XV.

FIG. 1. — *Myzostoma chelonium* sp. nov., dorsal view.
FIG. 2. — The same specimen, more highly magnified, ventral view.
FIG. 3. — *M. chelonoidium*, sp. nov., dorsal view.
FIG. 4. — The same, ventral view.
FIG. 5. — *M. antennatum* von Graff, ventral view.
FIG. 6. — *M. deani* sp. nov., ventral view.
FIG. 7. — *M. clarki* sp. nov., dorsal view.
FIG. 8. — The same, lateral view.
FIGS. 9, 10. — Cyst of the same, with a portion of the arm of the host attached

PLATE XVI.

FIG. 11. — *M. metacrini* sp. nov., ventral view.
FIG. 12. — *M. smithi* sp. nov., ventral view.
FIG. 13. — *M. japonicum* sp. nov., ventral view.
FIG. 14. — *M. cysticolum*, small individual, ventral view.
FIG. 15. — Large individual of the same, lateral view.
FIG. 16. — *M. wheeleri* sp. nov., ventral view.

PLATE XVII.

FIG. 17. — *M. clarki* sp. nov., half of cross-section of body of individual 4.5 mm long.
FIG. 18. — *M. smithi* sp. nov., half of cross-section of body of individual 3 mm. long.
FIG. 19. — *M. cysticolum* von Graff, half of cross-section of large individual 4.2 mm. long.
FIG. 20. — *M. metacrini* sp. nov., three-fourths of cross-section of individual 5 mm. long.
FIG. 21. — *M. antennatum* von Graff, half of cross-section of individual 3 mm. long.
FIG. 22. — *M. chelonium* sp. nov., half of cross-section of individual 2.1 mm. long. At *c* a piece of the cuticle is shown in surface view.
FIG. 23. — Enlarged section of cuticle of same.
FIG. 24. — *M. chelonoidium* sp. nov., half of cross-section of individual 2.4 mm. long.
FIG. 25. — *M. wheeleri* sp. nov., half of cross-section of individual 4 mm. long.
FIG. 26. — *M. cysticolum* sp. nov., half of cross-section of small individual 1.1 mm. long.
FIG. 27. — *M. deani* sp. nov., half of cross-section of individual 1 mm. long.
FIG. 28. — *M. japonicum* sp. nov., half of horizontal section of individual 2 mm. long.

[*May, 1906*].

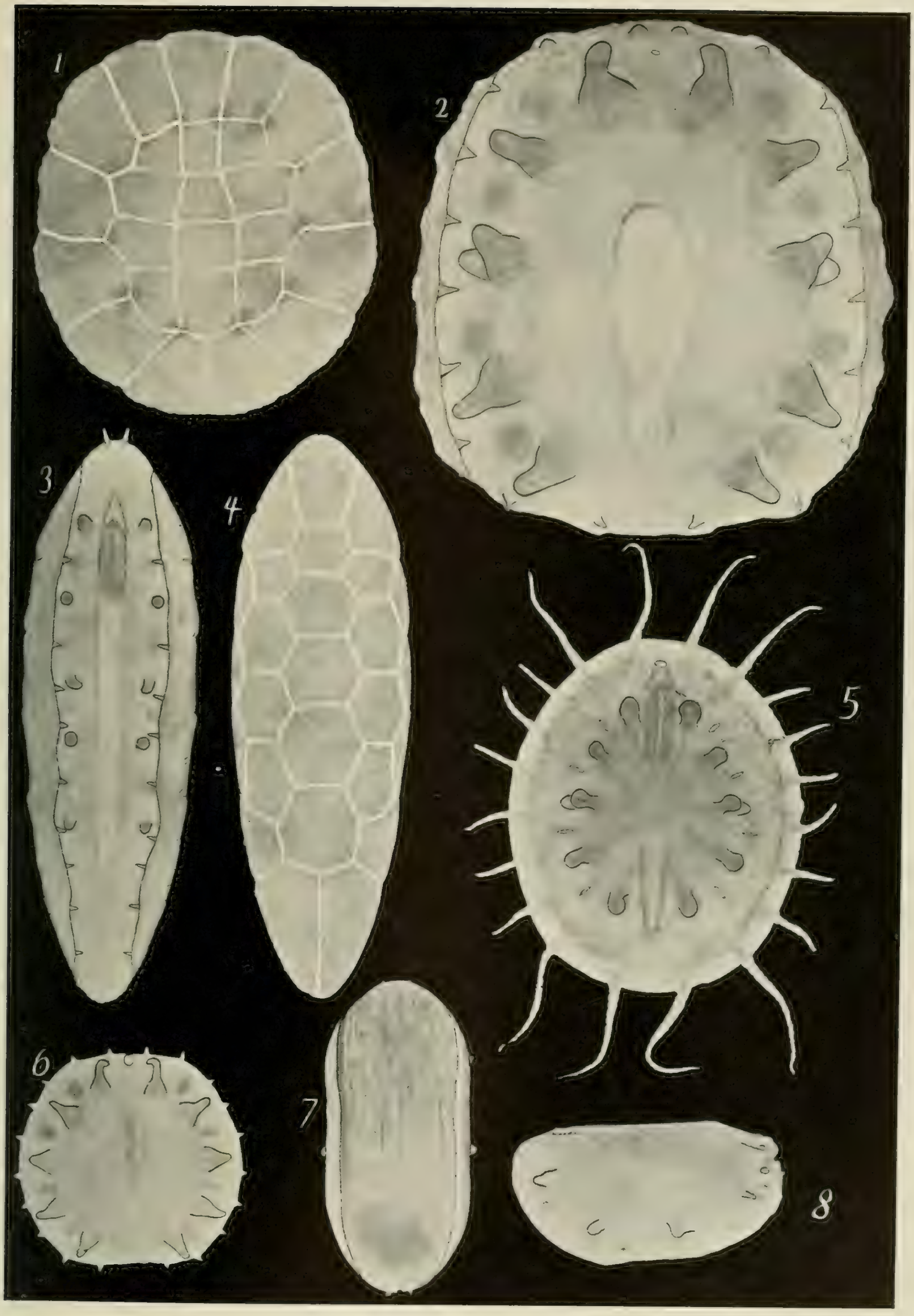
The following figures were drawn at stand level, camera lucida, Zeiss oil imm. ob. (Apochromat.) 1.5 mm., oc. 12, and then reduced to × ½.

Fig. 29. — *M. clarki* sp. nov., egg (primary oöcyte) in body cavity, showing the small dark nucleus of one of the accessory cells, imbedded in the cytoplasm of the egg.

Fig. 30. — *M. antennatum* von Graff. Two eggs (primary oöcytes) from distal portion of ovary each showing the nuclei of the two accessory cells, the cytoplasm of which is not distinct from that of the eggs. One germinal vesicle shows the chromatin in a spireme, the other at nodes of the linin reticulum.

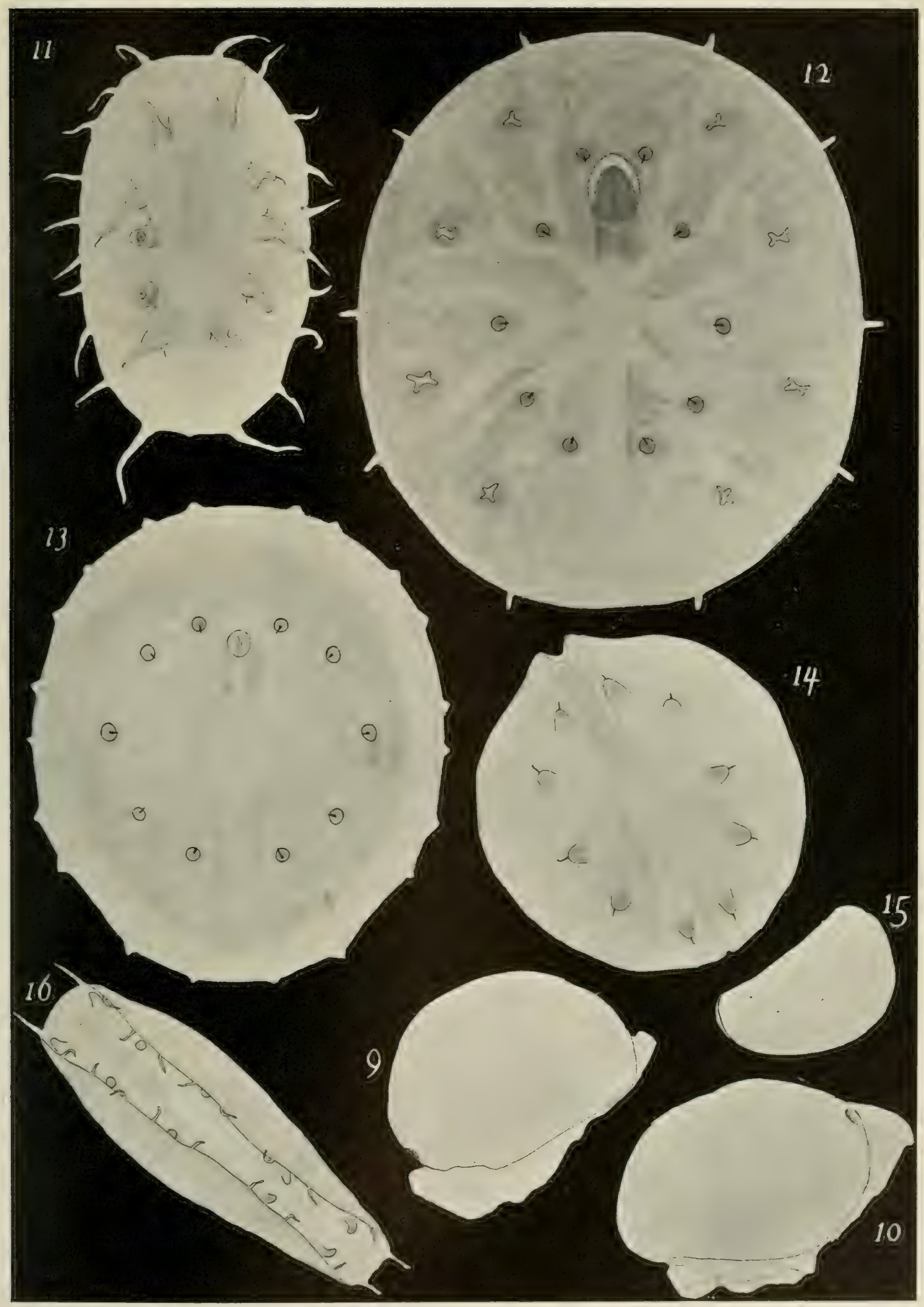
Figs. 31–34. — *M. japonicum* sp. nov., stages in the transformation of the spermatid into the spermatozoön. Only a short portion of the tails could be traced out, and could not be completed in the figures. In Fig. 31, the nucleus is beginning to elongate. The chromatin is in the form of numerous granules, probably in a reticulum of achromatic substance. In Fig. 32, the nucleus has elongated further. Fig. 33 is a piece of the elongated nucleus showing stages in the fusion of the granules to form the series of chromatic discs shown in the spermatozoōn (Fig. 34).

Biological Hall, Univ. of Pennsylvania,
January 3, 1906.



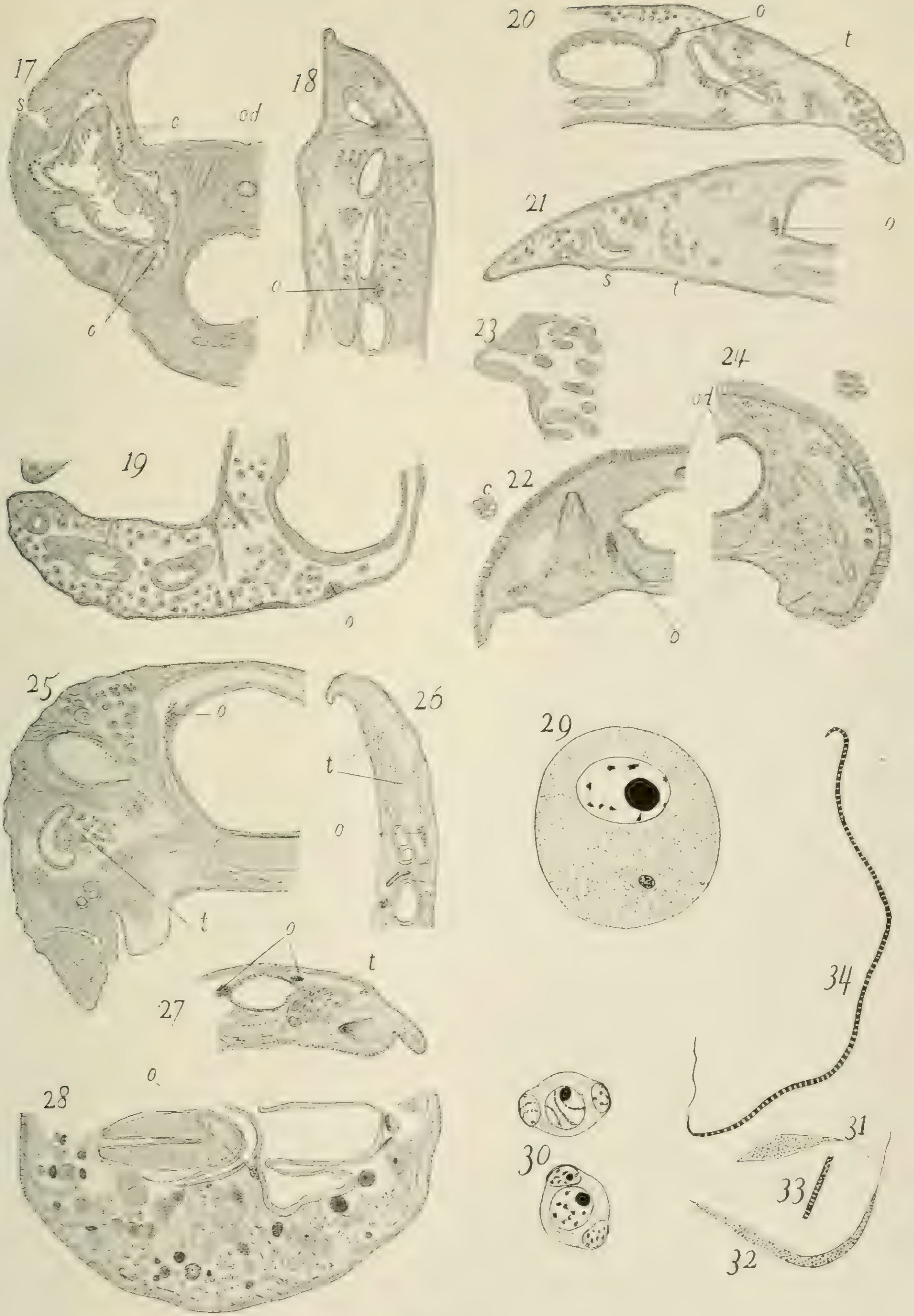
1, 2. *Myzostoma chelonium* sp. nov.
3, 4. " *chelonoidium* sp. nov.
5. " *antennatum* v. Graff.

6. *Myzostoma deani* sp. nov.
7–10. " *clarki* sp. nov.


11
12
13
14
15
16
9
10

11. *Myzostoma metacrini* sp. nov.
12. " *smithi* sp. nov.
13. " *japonicum* sp. nov.

14, 15. *Myzostoma cysticolum.* v. Graff.
16. " *wheeleri* sp. nov.


17
s
c
od
c
18
o
20
o
t
21
o
s
t
23
24
od
22
c
o
19
o
25
o
t
26
t
o
29
27
o
t
28
o
30
34
31
33
32

MYZOSTOMA.
Cross-sections, and sex cells, various species.

56.4,53 (1162:701)

Article VII.—NOTES ON SOME JURASSIC FOSSILS FROM FRANZ JOSEF LAND, BROUGHT BY A MEMBER OF THE ZIEGLER EXPLORING EXPEDITION.

By R. P. Whitfield.

Plates XVIII and XIX.

On October 19 the Museum received a small number of Jurassic fossils from Dr. J. Colin Vaughan, a member of the late Ziegler Northern Exploring Expedition, which he collected at and around Cape Flora, Franz Josef Land, during the years 1904 and 1905 while awaiting their relief ship.

In working these over for incorporation in the Museum catalogue, I find among them representatives of several of the Ammonites described and figured by Messrs. Newton and Teall (Quart. Jour. Geol. Soc. London, Vol. LIII, Dec. 1897, p. 496, pll. 39 and 40).

These authors have identified their specimens with species described by Schlotheim, von Keiserling, and D'Orbigney and have given no new names to them, except a varietal one under Keiserling's *Ammonites ishmæ*.

This is so greatly at variance with the modern method of many palæontologists and other workers in natural history as to make it quite remarkable, for the prevailing practice is to put a new name to everything coming from a new locality, both generic and specific, irrespective of what has been done by previous workers. Still it seems to me that in the present instance the opposite principle has been carried a step too far, for, judging from the specimens in the possession of the Museum, the forms *Am. schefkini* (?), *Am. macrocephalus* var., and *Am. ishmæ* var. *arcticus* are merely representatives of age-stages of one and the same species, and none of them represents the adult form of the Franz Josef Land species, or at any rate of that found abundantly at Cape Flora. The forms cited above represent the quite young; that of a further development; a middle stage, and a more advanced stage (*Am. ishmæ* var. *arcticus*) which still lacks the outer or adult volution.

At the adult stage the final features of the species are attained and the form differs in character from the less advanced stages. In the adult, the outer volution is nearly or quite smooth, without any of the strong corrugations characteristic of middle age or of the young. It has, moreover, a strong marginal or submarginal rib, thickened on the inside, running a little back from the edge of the aperture across the volution from the umbilicus outward. The final lip is produced in front on the peripheral part of the shell into a thickened rounded lip. The thickened rib just back of the margin of the aperture, as shown on our most perfect specimen, is fully half an inch broad at the umbilicus and extends to the periphery of the volution, with a rather strong forward flexure, amounting to about one fourth of the circle of the volution. This corresponds well to the flexure of the corrugations as seen on the quite young shells, although the flexure is much less, as seen faintly at the inner end of the body whorl, where the ribs are indistinctly marked. On another specimen of the outer volution, the marginal thickened rib is still more inclined forward, while on the inside of the same fragment, which represents the outer half of the previous volution, the ridges extend almost directly across the shell from the umbilicus to the dorsum and show the bifurcation and interstitial addition, just as they do in the most strongly corrugated middle-aged specimen (=*Am. ishmæ* var. *arcticus*).

To this adult form of the Franz Josef Land type I propose to restrict the varietal name *arcticus* and apply it to the whole species irrespective of the other names applied to those of the younger or immature stages of growth.

Since writing the above my attention has been called to a later article than Messrs. Newton and Teall's, above referred to, by J. F. Pompeckj in the Norwegian North Pole Expedition, 1893-1896, where the division into species and genera is carried still further than by Newton and Teall, making seven species and referring them to three distinct genera. From the study of their material as represented by the figures given on their Plate II, I can see no valid reason for considering them other than as individual differences of one and the same species. Consequently I must still hold to the opinion above expressed and conclude that they ought to be all placed as one under the name *Cadoceras arcticus*. I am thoroughly convinced that it is a perversion of the principle underlying the science of palæontology and natural history to multiply specific names to so great an extent.

Besides the Ammonites there are a few plants on a blackish shale containing several impressions of pine needles, pine seeds with the impression of the wing, one of *Ginkgo reiniformis* as identified in the work above cited, two or three *Ginkgo sibirica*, probably one *Ginkgo polaris* with short divisions looking very much like a Coal Measure *Sphenophyllum*, one *Podozamites* (?), some fragments of coniferous wood, a fragment of an *Equisetum*, and a single pinnule of a fern.

There are also several mollusks, one of which is identical with Pompeckj's *Macrodon schonrovski;* another may be identical with his *Pseudomonotis jacksoni*, but which I had considered as a species of *Halobia*; a pectenoid shell, possibly a *Camptonectes*, and probably equal to his *Pecten lindstromi; Eumicrotis curta* Hall, a nuculoid shell; a small *Yoldia;* an *Edmondia* (?); one small *Amberleya capatanaca* (Munst.) as identified by Pompeckj (p. 69, *ibid.*); several examples probably identical with *Leda*, sp. *nuda* (Von Keys.) Pomp., but which I had supposed represented the aptychus of an Ammonite. Also, one small rhynchonelloid Brachiopod, and a number of broken specimens of *Belemnites*, which I had considered as *B. densus* Meek.

Among the shells mentioned, there is one brachiopod (*Rhynchonella*?), one *Yoldia*, a *Nucula*, an *Arca*, and what I suppose to be *Camptonectes*, also one *Eumicrotis* and a *Turbo*(?).

There are also several fragments of Belemnites like those figured by Messrs. Newton and Teall, but which I should have identified with *B. densus* Meek, rather than with *B. panderi* D'Orb., and some four or five objects which I take to be the opercula or aptychi of Ammonites, and most likely belonging to *Ammonites arcticus* as herein recognized. There is also a rather imperfect specimen of a new form of bivalve crustacean somewhat allied to *Ceratiocaris* and its congeners.

Among many of the Ammonites of Mesozoic age, but more particularly among those of the more aberrant genera such as *Helicoceras* and *Heteroceras*, we know of a number that show the most extravagant development of individual differences in their old-age characters, for instance, *Heteroceras stevensoni*, of the Fox Hills group and Fort Pierre beds, as I have shown in the Museum 'Bulletin,' Vol. XVI, pp. 67-72, Pll. XXIII–XXVII, and also among those of the Japanese Cretaceous rocks as shown by H. Yabe in the 'Journal' of the Imperial University of Tokio, Japan, Vol. XX, Article 2.

Among the true forms of Ammonites, variations are not so marked, and yet among those of the Black Hills of Dakota Jurassic, as seen in the Museum collection, in a series of *Am. cordiformis* Meek and Hayden, there is noticed a much greater change between the very young, the middle-aged, and the adult individual than is shown among the specimens from Franz Josef Land. In young specimens the shell is comparatively thin through the umbilical region and the ridges flexuose and very distinct, features which increase or are maintained during early and middle life, when the back is strongly serrate with deeply cut teeth, while in the adult form all of these features are lost and the outer volution becomes smooth and the dorsum is only distantly irregularly nodose. The specimen measures 7¾ inches in its longest diameter and is fully 4 inches through the umbilical diameter, or more than half of the opposite diameter.

EXPLANATION OF PLATE XVIII.

Fig. 1.—The adult form here described, for which the name *Ammonites* (*Cadoceras*) *arcticus* is suggested. The imprint of the thickened marginal ridge is seen passing upward from the small umbilicus to the thickened lip-like extension in front, on the top of the figure.

Fig. 2.—The form given by Messrs. Newton and Teall as *A.* (*Macrocephalites*) *ishmæ* var. *arcticus*, and we now suggest the use of this varietal name for the species as found at this locality.

EXPLANATION OF PLATE XIX.

Figs. 1. and 2.—The form referred by Messrs. Newton and Teall to *Am.* (*Cadoceras*) *zechfkini* D'Orb., a species from Russia.

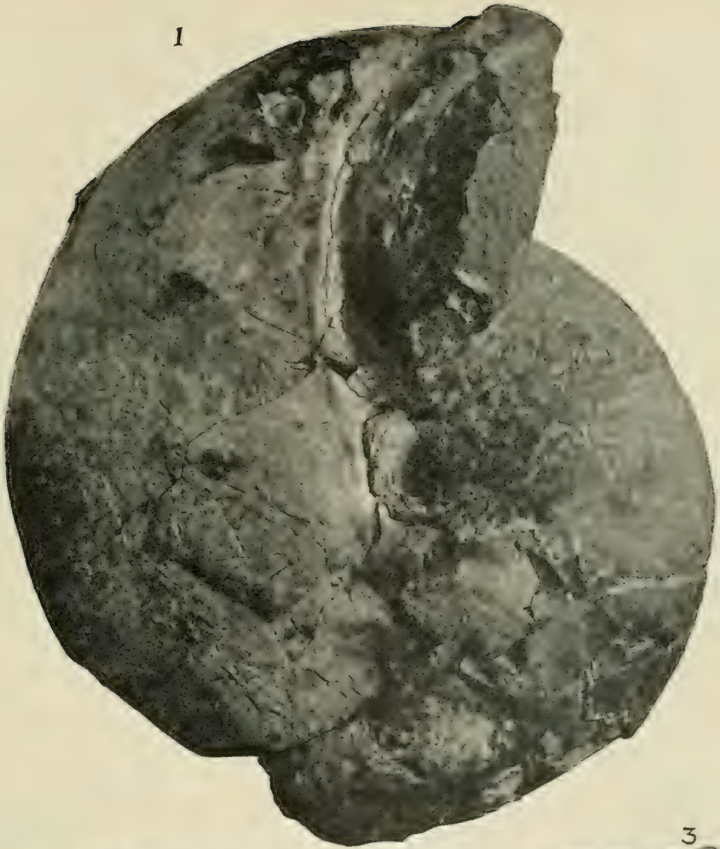
Fig. 3.—A specimen representing the form referred to *Am.* (*Macrocephalites*) *macrocephalus* Schlotheim, a very variable form and quite cosmopolitan in its distribution in Jurassic rocks.

Fig. 4.—A fragment of the outer adult volution of another specimen similar to that of Fig. 1 on Plate XVIII, showing the smooth surface of the adult and the trace of the thickened rib near the aperture.

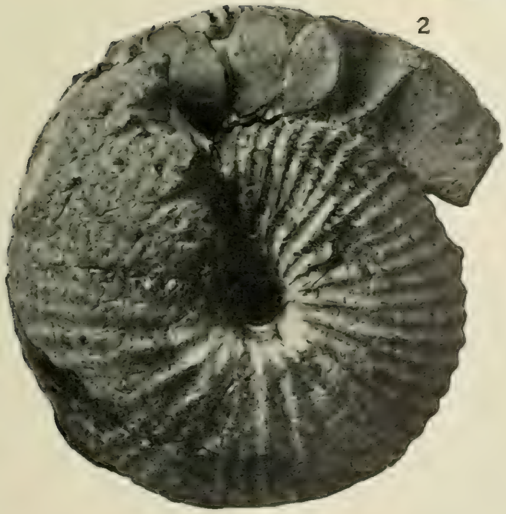
Fig. 5.—View of an impression in wax from the under-side of the specimen shown in Fig. 4, to show the corrugations of the inner volution, presenting the characters of *Amm.* (*Cadoceras*) *ishmæ* var. *articus* as given by Messrs. Newton & Teall, *loc. cit.* =*M. kœttlitzi* Pompeckj.

Figs. 6. and 7.—Views of two specimens of the Belemnites which Messrs. Newton and Teall referred to *B. panderi* of D'Orb., and by J. F. Pompeckj to *B. subextensus* Nik. (=*panderi D'Orb.*), *B. beyrichi* Opp., and *B.* sp. undet; Fig. 7, a specimen split longitudinally and weathered, showing the prevailing features of *B. densus* Meek and Hayden.

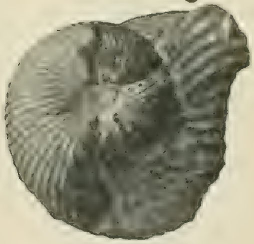
1



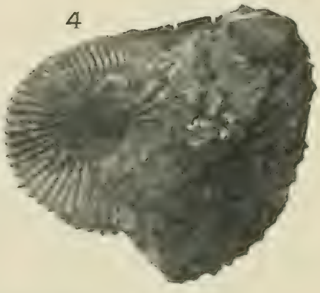
2



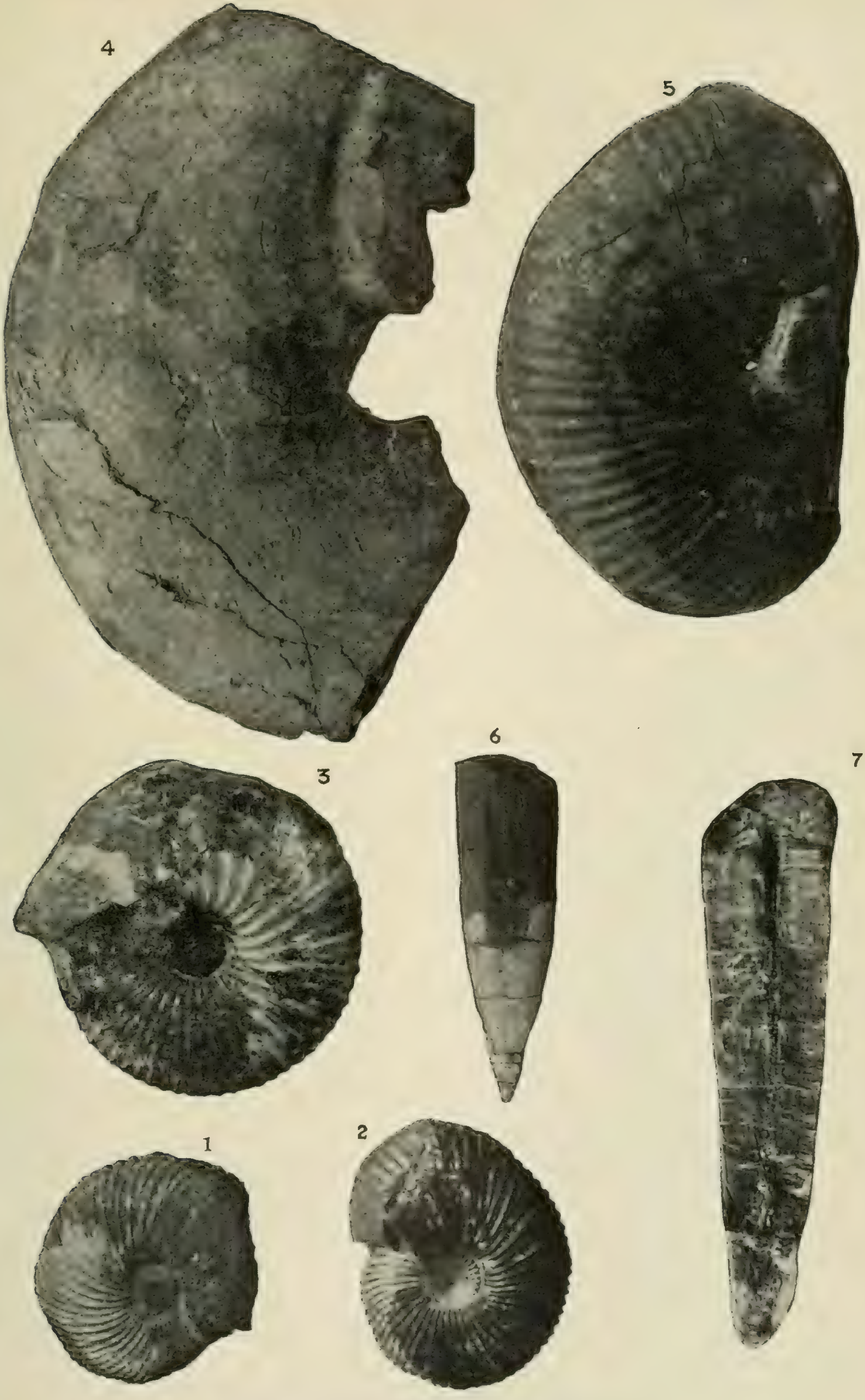
3



4



Jurassic Fossils from Franz Josef Land.



JURASSIC FOSSILS FROM FRANZ JOSEF LAND.

56.9,725E (1182:78.3)

Article VIII.—NEW OR LITTLE KNOWN MAMMALS FROM THE MIOCENE OF SOUTH DAKOTA.

AMERICAN MUSEUM EXPEDITION OF 1903.

By W. D. Matthew and J. W. Gidley.

Part IV.[1] Equidæ. J. W. G.

In the Loup Fork collection from South Dakota obtained by the 1903 Expedition, there are several species of horses represented. This new material adds much to our knowledge of the Miocene Equidæ.

The object of the present paper is simply to report the known species represented and to describe new material. A complete revision of all the Miocene horses will be undertaken in a future publication.

Hypohippus affinis *Leidy.*

This species, the type of the genus, is apparently represented in the collection by a fragment of lower jaw containing three teeth, p_3, p_4, and m_1, of the permanent series (No. 10834 Amer. Mus. Coll.) from the upper Miocene formation (Loup Fork beds) at Big Spring Cañon. The characters of the adult teeth of the genus *Hypohippus* are well known from *H. equinus* (*Anchitherium equinum* Scott), an older Miocene form, but *H. affinis* is at present known only from the type tooth, an upper milk molar dp,[4] from the Loup Fork beds in the vicinity of Fort Niobrara, Nebraska. Hence the reference to this species of the lower teeth from Big Spring Cañon is only on the ground of equality in size and inferred height of the molar crowns, and of its derivation from the same formation at a locality not far removed from that of the type.

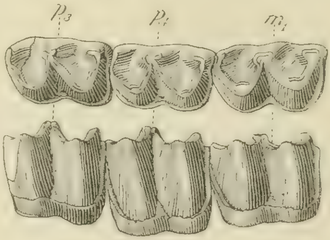


Fig. 1.—*Hypohippus affinis* Leidy. Lower teeth, half natural size. No. 10834. Loup Fork formation, South Dakota.

Compared with the corresponding teeth in *H. equinus* they show a marked progressive stage, especially in (1) their greater size; (2) their proportionately longer crowns; and (3) the better development of the metastylid which, at its summit in the little worn teeth, is slightly separated from the metaconid by a shallow groove which extends but a short distance down the side of the metaconid pillar. The continuous external basal cingulum is well developed in a broad heavy band of enamel.

---

[1] Parts I and II were published in this Bulletin, Vol. XX, 1904, pp. 241-268. Part III will be published later.

Measurements.

		Antero-post.	Transv.
Diameters of type tooth,	dp^4	27 mm.	29 mm.
Diams. of lower teeth (No. 10834)	p_3	28 "	20 "
	p_4	27.5	21 "
	m_1	28.5 "	20 "

Height of crown, p_4, inside 20 mm., outside 25 mm.

Hypohippus sp. indet.

A single left lower molar (No. 10835 Amer. Mus. Coll.), m_1 or m_2, from Big Spring Cañon, represents a second Upper Miocene species of *Hypohippus* much smaller than *H. affinis*.

This tooth shows less progressive characters: (1) The crown is relatively shorter; (2) the metastylid is less developed, with no separating notch; (3) the basal cingulum is relatively weaker and narrower. The tooth is larger than the corresponding one in *H. equinus*. It differs further from that species in having a narrower cingulum and somewhat greater comparative height of crown.

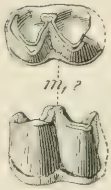


Fig. 2.—*Hypohippus* sp. indesc. Lower molar, half natural size. No. 10835. Loup Fork formation, S. Dakota.

The measurements are:

Antero-post. diameter	23.5 mm.
Transv. "	23 "
Height of crown inside	12 "
" " " outside	16 "

The tooth probably represents an undescribed species, but we prefer not to name a species on such an incomplete and uncharacteristic specimen.

Protohippus perditus *Leidy.*

This species is represented by a nearly complete skull (No. 10838 Amer. Mus. Coll.), which may be regarded as a hypotype,[1] and a well preserved palate containing the milk molars (No. 10866), both from the Loup Fork beds of the Little White River near the Rosebud Indian Agency, South Dakota.

---

[1] See Schuchert's definition, Science, Vol. V, 1897, p. 637.

The skull is of a young individual still retaining the milk molars, but with m^1 fully formed and slightly worn and m^2 just protruding from the bone. Though young it presents some distinctive characters which add to our knowledge of this important species, which is the type of the genus *Protohippus*, and among the first of the three-toed horses described from this country.

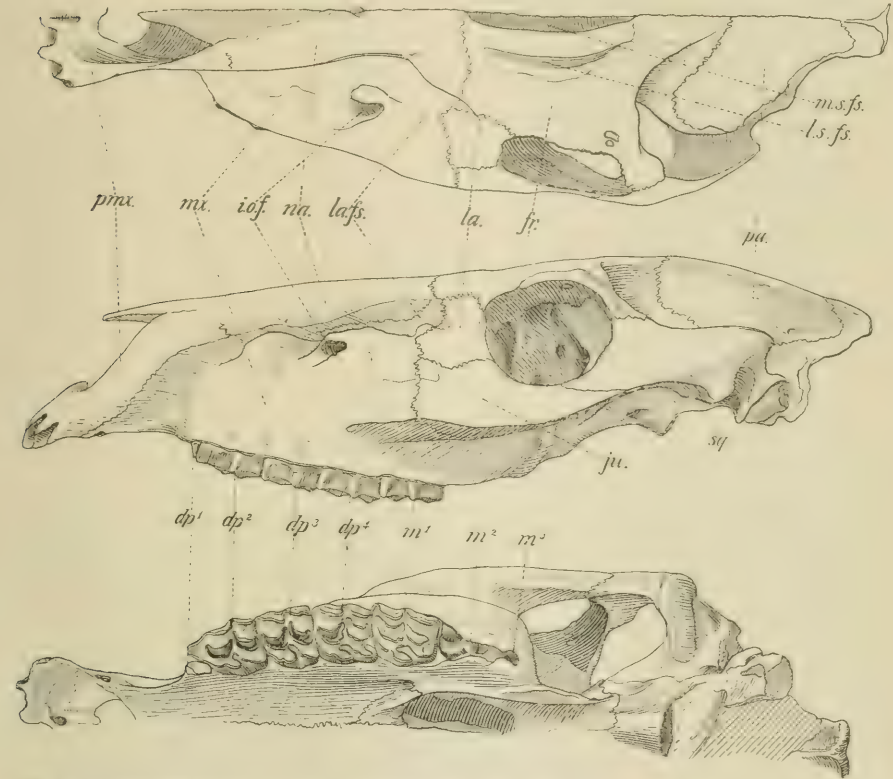


Fig. 3.—*Protohippus perditus* Leidy. Immature skull, one third natural size. Hypotype, No. 10338, Loup Fork formation, Little White River, S. Dakota.

pmx., premaxillary; *mx.*, maxillary; *na.*, nasal; *la.*, lachrymal; *fr.*, frontal; *pa.*, parietal; *ju.*, jugal; and *sq.*, squamosal bones of the skull. *La. fs.*, lachrymal fossa; *m. s. fs.*, *l.s. fs.*, median and lateral superior (frontal) fossæ; *i. o. f.*, infraorbital foramen.

A section of the first true molar, taken at about the same height above the fangs to which m^1 of the type was worn by use, agrees nearly with that tooth in size and characters of tooth pattern. This, with the close correspondence of the malar region of the face with so much of the same region as is prererved in the type specimen, makes the reference to this species reasonably positive.

The milk molars, as is always the case in *Protohippus*, are hypsodont in form and heavily cement covered, though much shorter-crowned and proportionally narrower transversely than the teeth of the permanent series which succeed them. The transversely narrow proportions of the milk teeth, however, are characteristic of all horses.

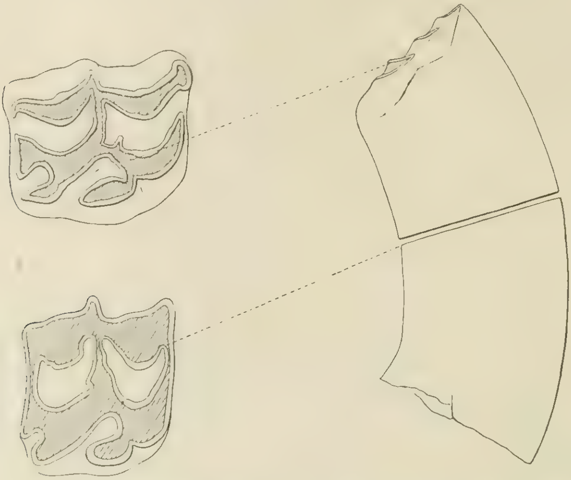


Fig. 4.—*Protohippus perditus* Leidy. Hypotype. No. 10838. Crown and sectional views of first true molar, natural size.

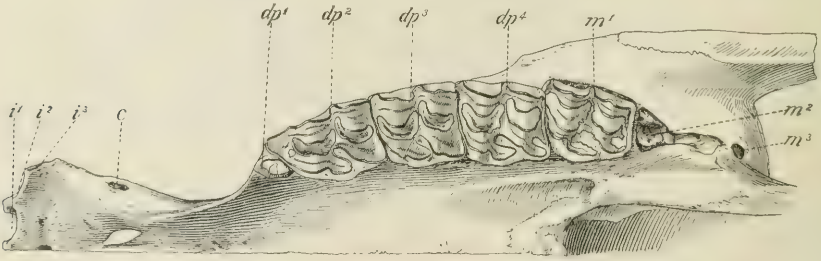


Fig. 5.—*Protohippus perditus* Leidy. Upper jaw, half natural size. Hypotype, No. 10838.

Compared with *Neohipparion whitneyi* the skull is proportionally shorter, especially in the region of the muzzle, and relatively less in vertical depth. The palate is moderately arched, being especially high forward of the premolars, a character observed in all the zebra skulls compared, and the maxillaries are deeply constricted in this region. The anterior palatal foramina are small, oval in outline, and do not extend as far forward as in *N. whitneyi.* The basisphenoid is very short and broad and is overlapped by the vomer. The side face is marked by a single fossa, the lachrymal,[1] which begins in a depression in the lachrymal bone and runs forward along the line of the naso-maxillary suture. This pit is long, moderately deep at its posterior end, but not sharply outlined. The top view of the skull is very remarkable. The nasals are very broad at the point of articulation with the premaxillaries. Passing backward they curve deeply in and downward on either side to form the upper portion of the lachrymal fossæ, thus greatly constricting the top of the skull in this region. The lachrymal fossæ are plainly seen from the top view, and in addition to these are three long symmetrically arranged furrows in the middle forehead region, the median deep, long, and straight, the lateral ones shorter, shallower, and crescentic. If these frontal fossæ are normal, they present a unique character.

Measurements.

(Type Specimen.)

	Antero-post.	Transv.
Diameters of m^1	19.5 mm.	22 mm.
" " p^4	20 "	22 "

Length of molar series.......................... 59 mm.

Skull No. 10838.

	Antero-post.	Transv.
Diameters of m^1 (triturating surface)	23 mm.	18 mm.
" " " (cut section)	20 "	22 "

Length of milk molar series	76 mm.
Length of muzzle, p^2 to i^1	58 "
Width of palate between first premolars	38 "
Width of palate at narrowest point	23 "
Width across incisive border	48 "
Depth of skull at m^1 (estimated)	85 "

Protohippus simus sp. nov.

Type (No. 9820 Amer. Mus. Coll.). Anterior portion of adult skull with nearly complete dentition, from the Little White River.

A second adult specimen (No. 10871), consisting of fragmentary upper jaw with p^2 to p^4, m^2 and m^3, from the Niobrara River locality, is referred to this species.

---

[1] In many skulls of Miocene horses there are two distinct preorbital fossæ, hence it is of great convenience to employ a more distinctive term for each. The upper fossa, though formed principally in the nasal and maxillary, usually has its origin in the lachrymal bone, hence this term which has already been used seems appropriate. In the lower depression the posterior border is in the malar bone, hence the term " malar fossa " may be appropriately used to designate its position.

These specimens represent an animal very distinct from species of the *P. mirabilis* and *P. supremus* type, but apparently more closely allied to *P. perditus*, though somewhat larger and differing from that species in the following characters:

In the upper teeth the protocones show a more progressive stage in their fuller development anteriorly, thus forming a deeper infolding of the enamel between them and the protoconules. In other respects the teeth do not differ greatly from those of *P. perditus* except that the cement lakes are narrower transversely.

The chief points of difference are in the skull characters. The muzzle is short but much broader than in *P. perditus*. The incisive border is but little curved. This, together with its great breadth, gives the muzzle a rather truncate appearance.

The palate is broader and less arched than in *P. perditus*, especially forward of the premolars, where it is relatively very flat. The anterior palatine foramina are elliptical in outline and are placed in about the same relative position as in *P. perditus*.

The malar fossa is wanting, as in *P. perditus*, and the lachrymal fossa is broader, much shallower, and less sharply defined than in that species. The skull appears to have a comparatively great vertical depth, but this may be due in part to distortion, as it is somewhat compressed laterally.

Measurements.

Type (No. 9820).

Length of dental series m^3 to i^3	200	mm.
“ “ molar-premolar series m^3 to p^2	135	“
“ “ molar series	62	“
“ “ diastema between canine and i^1	15	“
“ “ muzzle from p^2 to i^1	65	“
Diameters of m^1 (antero-posterior)	20	“
(transverse)	23	“
Diameters of p^4 (antero-posterior)	21	“
(transverse)	24.5	“
Width of palate between fourth premolars	48	“
“ “ “ “ first “	41	“
“ “ “ at narrowest point	31.5	“
“ across incisive border	61	“
Depth of skull taken in line with m^1	112	“

Protohippus placidus *Leidy.*

P. placidus is apparently an abundant species in the Loup Fork beds, and is represented by several well preserved specimens in the collection from Big Spring Cañon and the Little White River. Four fragmentary upper jaws containing teeth (Nos. 10830, 10826, 10843, and 9830), and five more or less fragmentary lower jaws (Nos. 10849, 10850,–a, 10853, 10855, and 10857), are apparently referable to this species. Since, with possibly a few exceptions, the specimens referred by Cope to this species were wrongly identified, *P. placidus* has really been known only from the type specimen and three other single teeth, all second upper premolars, reported by Leidy, from the Little White River. These teeth, including the type, agree in size and general character with those of the specimens collected by us in the same locality. This new material now admits of a clearer and fuller definition of the species.

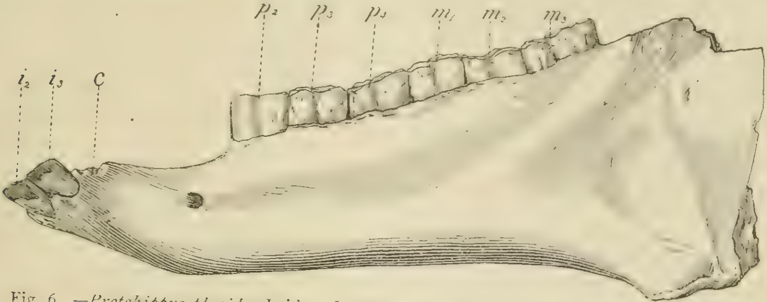


Fig. 6. —*Protohippus placidus* Leidy. Lower jaw, external view, half natural size. No. 18040, from Loup Fork formation, Little White River, S. Dakota.

In the upper molariform teeth the protoconules are joined with the protocones which are directed well backward as in *P. perditus*, and the borders of the cement lakes have a like simplicity of enamel folding, but they differ from that species in (1) their much smaller size; (2) their greater comparative length; (3) less curvature of the crowns; and (4) the relatively less transverse width of the cement lakes, especially in the true molars.

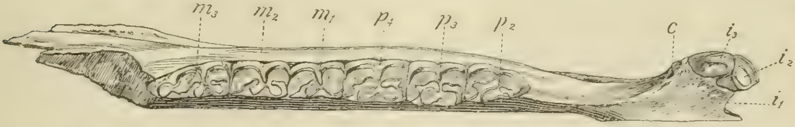


Fig. 7.—*Protohippus placidus* Leidy. Lower jaw, superior view, half natural size. No. 10849.

The fragment of skull preserved in No. 10830 shows there is a slight depression in the malar bone immediately in front of the orbit, but otherwise the face in this region is full and smooth as in *P. perditus*. Judging from what is shown in this imperfect specimen the lachrymal fossa, which is present is shallow and not sharply defined.

The lower jaw is short, and very deep behind the molars. It tapers rapidly forward to the symphysis with the lower border of the ramus nearly straight. The external pair of incisors are much smaller than the others and are not fully cupped. In the comparative length and relatively slight curvature of the tooth-crowns and the general form of the cement lakes, the teeth of this species resemble *Neohipparion* rather than *Protohippus*, yet under the definition it belongs to the latter genus.

Measurements of the principal specimens referred to *P. placidus* are as follows:

Upper Jaw No. 10830.

	Antero-post.	Transv.
Diameters of p^2	17.5 mm.	14.5 mm.
" " p^3	15 "	17.8 "
" " p^4	15 "	18.3 "
" " m^1	13.2 "	17 "
" " m^2	15.3 "	17.5 "
" " m^3	16.5 "	16 "

Total length of molar-premolar series excluding p^1 . . 102 mm.

Upper Jaw No. 10826.

	Antero-post.	Transv.	Height of mesostyle.
Diameters of p^4	17.5 mm.	17 mm.	43.5 mm.
" " m^1	16.5 "	16 "	39 "
" " m^2	17.5 "	15 "	45 "
" " m^2 near base of crown	14.5 "	17.5 "	

Lower Jaw No. 10849.

	Antero-post.	Transv.
Diameters of p_2	15 mm.	10 mm.
" " p_3	15.5 "	11 "
" " p_4	17 "	10.5 "
" " m_1	14.5 "	8.5 "
" " m_2	15 "	8.5 "
" " m_3	20 "	8.5

Total length of molar-premolar series . . . . 98 mm.

Protohippus mirabilis (*Leidy*).

This species appears to be represented in the collection by a fragment of maxillary bone containing two well worn teeth, m^1 and m^2 of the permanent series (No. 10840 Amer. Mus. Coll.).

The teeth agree in size and general character with those of the type, and the malar fossa and portion of the masseter ridge preserved correspond well with those in that specimen. A feature apparently characteristic of the very deep malar fossa in *P. mirabilis* is that it is double, being divided by a low, rounded ridge running parallel with the tooth crowns which underlie it.

Protohippus supremus (*Leidy*).

A fragmentary skull and lower jaws possessing the milk molars (No. 10844), and a fragment of maxillary containing $p,^3$ $p,^4$ and part of p^2 (No. 10858), both from the Little White River, apparently represent this species, which was founded on a single upper molar m^1 or m^2.

Cope considered *P. supremus* synonymous with *P. mirabilis* Leidy.[1] But the type tooth is too large for that species and moreover agrees well both in size and character with the fully formed m^1 preserved in the young skull No. 10844, which is clearly distinct from *P. mirabilis*. Hence *P. supremus* seems now to be well founded.

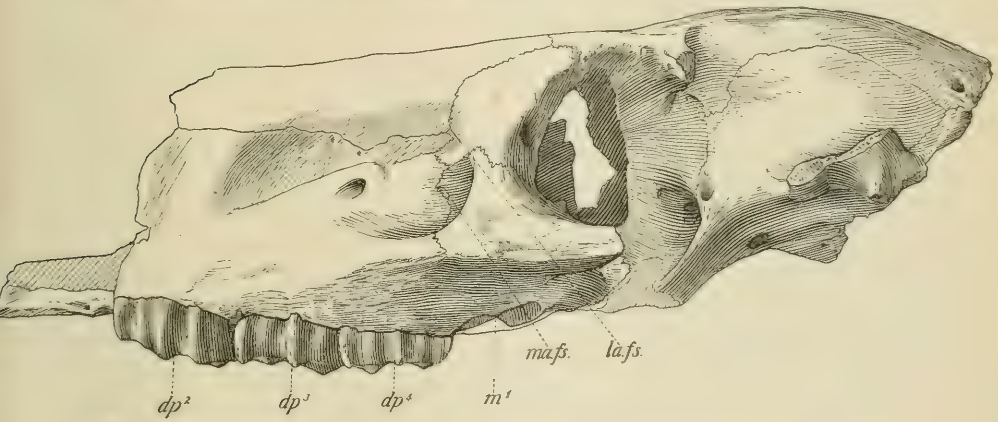


Fig. 8.—*Protohippus supremus* Leidy. Skull of young individual, half natural size. No. 10844, Loup Fork formation, Little White River, S. Dakota. *La. fs.*, Lachrymal fossa; *ma. fs*, malar fossa; dp_{2-4}, milk premolars.

Comparing skull No. 10844 with the type of *P. mirabilis* (1) the teeth are larger, (2) the crowns of the milk molars are comparatively longer and (3) are proportionally narrower transversely. (4) The enamel foldings bordering the fossettes in both the milk and permanent molars are more simple. (5) The crowns of the permanent molars are of moderate length and very much curved.

The malar fossa has no dividing ridge, and is comparatively smaller and shallower than in *P. mirabilis*. The pit ends posteriorly in a small backwardly directed pocket in the malar bone.. This portion of the malar pit is not preserved in the type of *P. mirabilis*. The lachrymal fossa occupies the same relative position as in *P. perditus* but is shallower and is less sharply defined than in that species. The basisphenoid is proportionally longer than in *P. perditus* and is not overlapped by the vomer.

---

[1] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), p. 25.

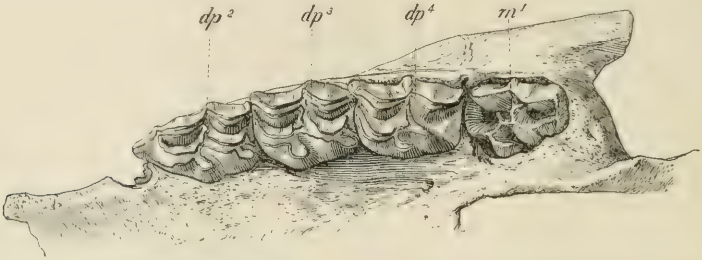


Fig. 9.—*Protohippus supremus* Leidy. Upper jaw with milk premolars, half natural size. No. 10844.

Pliohippus robustus Marsh agrees very closely in size and general characters with this species.

Protohippus (Pliohippus) pernix (*Marsh*).

A palate with the milk molars and the preformed m^1 of both sides (No. 10836), from Big Spring Cañon, and a fragment of upper jaw of a second young individual containing the preformed m^1 (No. 10827), from the Little White River, indicate a still larger species than *Protohippus supremus*. These specimens may represent an undescribed species, but we prefer at present to provisionally refer them to *Pliohippus pernix* Marsh, although the type of that species is smaller and seems to correspond more nearly with *Protohippus supremus*.

Both specimens being of young individuals may be compared very accurately with the specimens referred to *P. supremus*. The teeth are larger than in *P. supremus* but are proportionally shorter crowned. Dp^1 is comparatively large with an unusually long antero-posterior diameter. The protocone in m^1 is relatively larger and broader antero-posteriorly. There is a deep fold of the enamel in the cement valley between the protocone and metaloph. In *Protohippus perditus* and *P. supremus* this enamel fold seems to be wanting or only slightly developed.

The masseter ridge and malar fossa, which are preserved in No. 10827, also show some differences. The malar fossa is intermediate in comparative size and depth between *P. mirabilis* and *P. supremus* but is undivided as in *P. supremus.* The masseter ridge is comparatively thin and sharply defined.

Measurements, No. 10836.

	Antero-post.	Transv.[2]	Height of mesostyle.
Diameters of dp^1	19 mm.	7.5 mm.	10.5 mm.
" " dp^2	36 "	22.5 "	17 "
" " dp^3	27.5 "	26 "	20 "
" " dp^4	29 "	25 "	23 "
" " m^1	28 "	26 "	
Total length of milk molar series, dp^2 to dp^4			92.5 mm.

Neohipparion occidentale (*Leidy*).

A few isolated teeth (No. 10827), apparently represent *N. occidentale* in the 1903 collection, but they add nothing to our knowledge of the species.

Neohipparion gratum (*Leidy*).

This species is resented by sepreveral specimens from the Little White River. The most complete are a portion of skull with all the teeth except the molar-premolar series of one side (No. 10863), a complete pair of lower jaws (No. 10845), and two other lower jaws

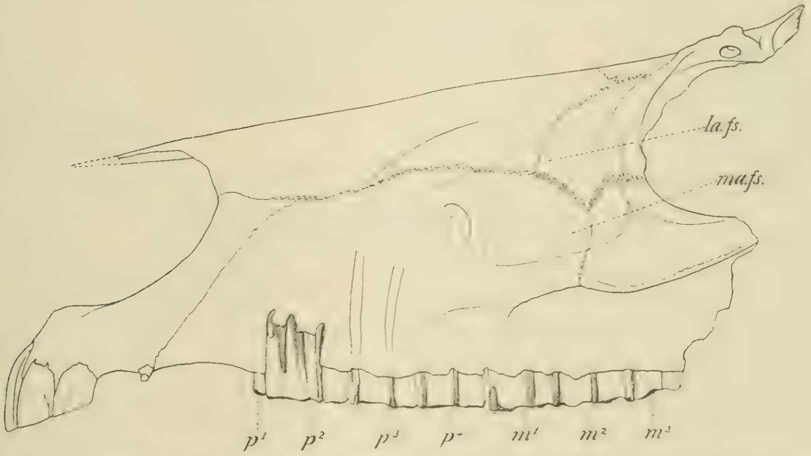


Fig. 1c.—*Neohipparion gratum* Leidy. Anterior part of skull, side view, half natural size. No. 10863. *La. fs.*, lacrymal fossa; *ma. fs.* malar fossa.

---

[1] Transverse diameter taken across base of tooth, not at triturating surface.

[*May, 1906*].

(Nos. 10851 and 10855). Other specimens in the 1903 collection referred to this species are a fragment of lower jaw containing teeth, p^2 to m^2 (No. 10862), and two fragments of young jaws containing the milk molars (Nos. 10854 and 10860). The type tooth, with a few other isolated upper teeth, reported by Leidy from the Little White River locality, have hitherto represented all that was known of this species.

Cope considered it synonymous with *Protohippus placidus*,[1] but, though the teeth are only slightly larger than those of *P. placidus* and have in common comparatively long and slightly curved crowns, they cannot be referred, under the definition, to that genus. The protocone in *N. gratum* is free for the greater part of its length, while in *P. placidus* the protocone is joined to the protoconule for nearly its entire length. The new material shows other characters which make yet clearer distinctions between the two species.

The protocones are usually small, and elliptical in cross-section. The enamel borders of the fossettes are a little more deeply folded than in *P. placidus*. A marked difference is the presence of a single deep fold in the anterior border of the anterior fossette. This fold does not appear in any specimen of *P. placidus* or *P. perditus*, but seems to be always present in little or moderately worn teeth of all *Neohipparion* species. Further distinctions are shown in the skull and lower jaws. Both the lachrymal and malar fossæ are present in skull No. 10863, but they are moderately deep and are limited in extent. There is also a broad, shallow depression in the middle of the forehead. The palate is high-arched, especially in the anterior portion. The anterior palatal foramina open backward into long, narrow slits left between the palatal portion of the premaxillaries and maxillary bones. This character is apparently universal in all

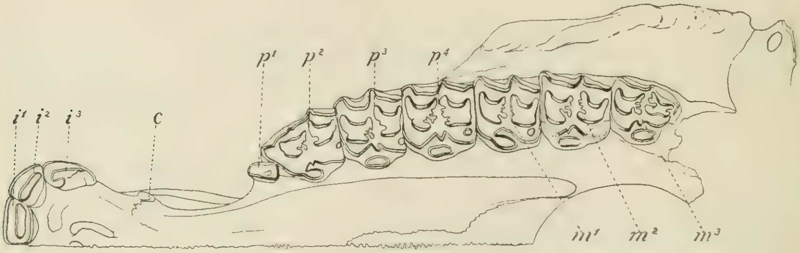


Fig. 11.—*Neohipparion gratum* Leidy. Upper jaw, inferior view, half natural size. No. 10863, from the Loup Fork formation, Little White River, S. Dakota.

---

[1] Geol. Surv. Texas, 4th. Ann. Rept. 1892 (1893), p. 26.

modern species of horses. The nasals are short-tipped, but very broad where they join the premaxillaries, thus forming a full, round anterior narial opening.

The lower jaws are short and deep as in *P. placidus*, but with the following differences: (1) The symphysis is longer and somewhat heavier, though the length of the jaw forward of the premolars is comparatively a little less than in *P. placidus;* (2) the angles of the jaws are proportionately smaller; and (3) the lower borders of the rami are much curved or bowed. This character is apparently common to the species of *Neohipparion.*

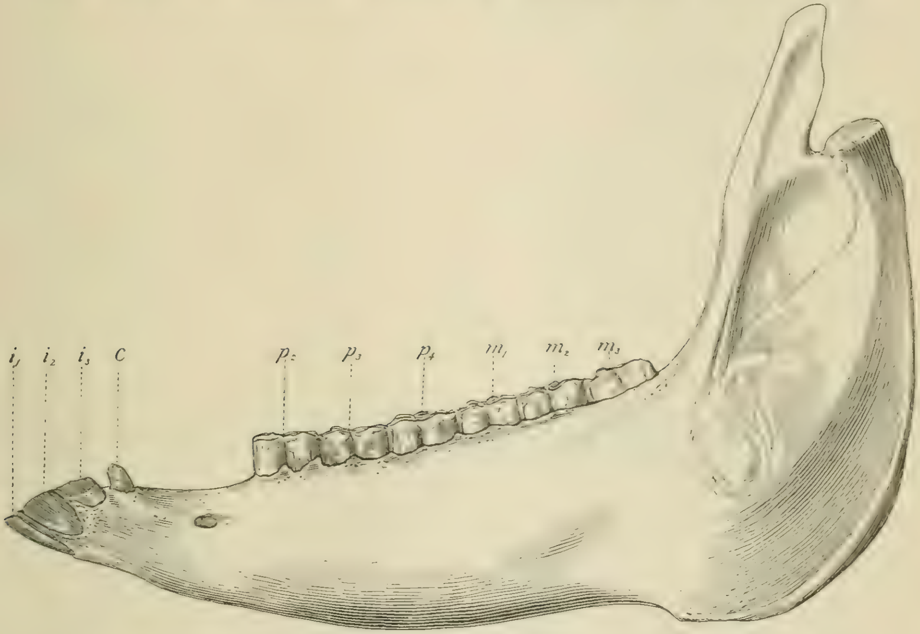


Fig. 12.—*Neohipparion gratum* Leidy. Lower jaw, external view, half natural size. No. 10845, Loup Fork formation, Little White River, S. Dakota.

Measurements of Specimens referred to N. gratum.

Skull No. 10863.

	Antero-post.	Transv.
Diameters of p^1	8 mm.	5 mm.
" " p^2	20.5 "	18 "
" " p^3	18. "	20 "
" " p^4	18.5 "	20 "
" " m^1	17.5 "	10 "

Diameters of m^2	17.5 mm	18.5 mm
" " m^3	17.5 "	15 "
Total length of dental series m^3 to i^1		179 "
Length of molar-premolar series p^1 to m^3		113 "
Length of diastema between p^1 and i^3		42.5 "
Width of palate between first molars		50 "
Width of palate between second premolars		35 "
Width of palate in front of first premolars		21.5 "
Width across incisive border		43 "
Height of skull above m^1		85 "
Distance from orbit to anterior narial notch		110 "

Lower Jaw. No. 10845.

Total length of jaw	248 mm
Length of molar-premolar series p_2 to m_3	111.5 "
Length of dental series m_3 to i_1	179 "
Length of diastema between p_2 and i_3	42 "
Width of symphysis at narrowest point	26 "
Width across incisive border	39.5 "
Depth of jaw at m_1	60 "
Height of condyles above bottom of jaw	136 "

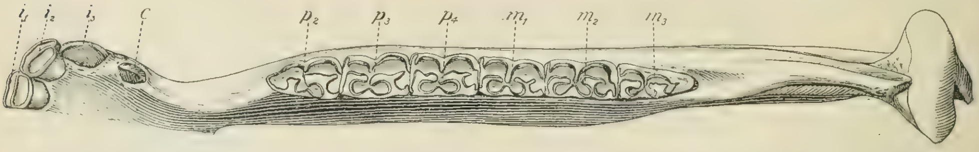


Fig. 13.—*Neohipparion gratum* Leidy. Lower jaw, superior view, half natural size. No. 10845.

Neohipparion whitneyi *Gidley.*

This species is represented in the 1903 collection by a skull with lower jaws and part of skeleton of a young individual (No. 10869), which is unfortunately in a poor state of preservation, and an upper premolar, p^3 (No. 10843*a*). Both specimens are from the cañon of the White River. They add nothing to our knowledge of the species.

Neohipparion dolichops sp. nov.

Type. A portion of upper jaw containing teeth, p^2 to m^2 (No. 10865 Amer. Mus. Coll.), from the Little White River. *Paratype.* Complete lower jaws with associated upper molar, m^2 (No. 10832), from Big Spring Cañon.

These specimens represent a species about equal in size to *N. affine* (Leidy). But they differ from that species in (1) the more open fossettes in the upper teeth, (2) the greater complexity of the enamel foldings, and (3) the proportionally smaller and more rounded protocones.

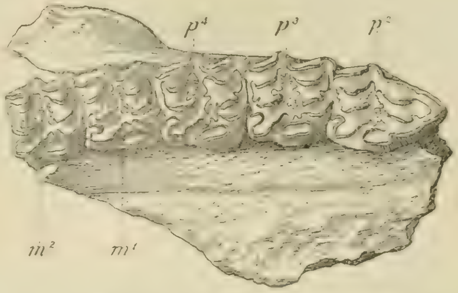


Fig. 14.—*Neohipparion dolichops* sp. nov. Upper jaw, type specimen, half natural size. No. 10865. Loup Fork formation, Little White River, S. Dakota.

From *N. occidentale* this species differs in (1) its smaller size and (2) different proportions of the premolars, which are relatively broader transversely.

Compared with *N. whitneyi* it is distinguished by (1) its smaller size and (2) by the greater number of folds in the enamel walls of the metaloph in the upper teeth, (3) the more open fossettes, and (4) the more rounded forms of the protocones. The small portion of skull preserved in the type does not admit of many comparisons, but a distinctive feature is shown in the extreme forward position of the infraorbital foramen, which is placed directly above the space between p² and p.³ The masseter ridge extends but little farther forward than in *N. whitneyi.*

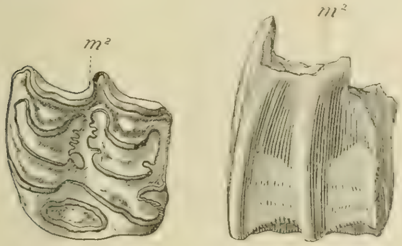


Fig. 15.—*Neohipparion dolichops.* Paratype, No. 10832. Upper molar. Natural size. Loup Fork formation, Little White River, S. Dakota.

The lower jaw is much longer and more slender than in *N. whitneyi*, or any other known Miocene species of horse. The muzzle portion is proportionally longer than the average of a dozen specimens of *Equus caballus* examined.

The lower border of the ramus is bowed as in *N. whitneyi* and *N. gratum.*

Measurements of Type (No. 10865).

	Antero-post.	Transv.
Diameters of p²	30 mm.	22 mm.
" " p³	23 "	23.5 "
" " p⁴	23.5 "	23 – "
" " m¹	20 "	22 "
" " m²	20 "	21.5 "

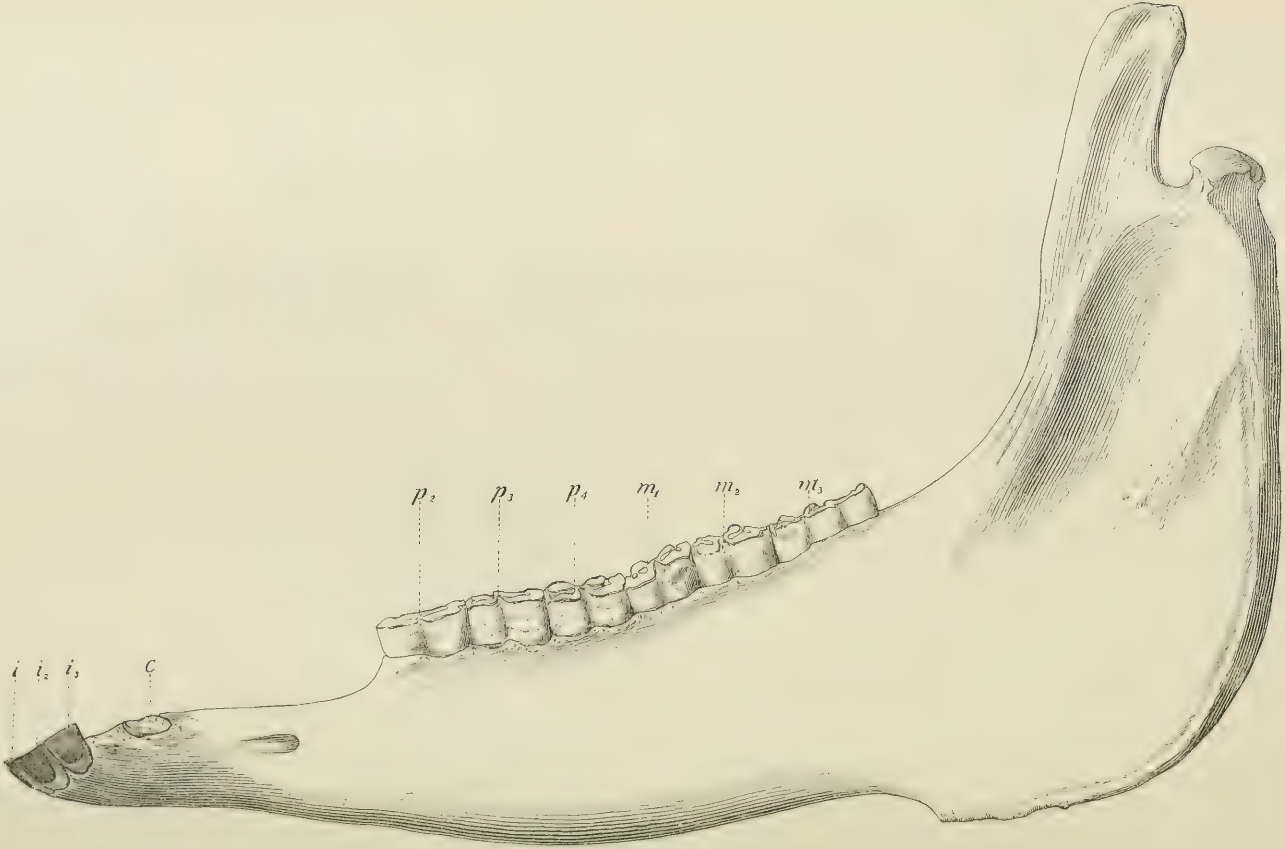


Fig. 16.—*Neohipparion dolichops.* Paratype, No. 10832. Lower jaw, external view, half natural size. The depth of the symphyseal region has been exaggerated in the drawing and its length somewhat reduced in proportion to the remainder of the jaw.

Lower Jaw and Upper Molar (No. 10832).

	Antero-post.	Transv.
Diameters of upper molar m_2	21 mm.	21 mm.

Total length of jaw	352	mm.
" " " molar-premolar series	138	"
Length from p_2 to and including i_1	108	"
" of diastema between p_2 and i_3	83	"
Width of symphysis at narrowest point	28	"
" across incisive border	45	"
Width of jaw across last molars (outside)	65	"
" " " " condyles (outside)	122 –	"

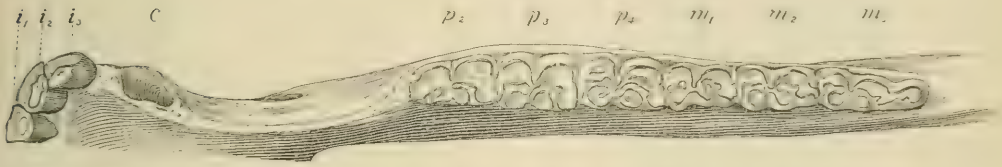


Fig. 17.—*Neohipparion dolichops.* Lower jaw, superior view, half natural size. Paratype, No. 10832.

(?)**Neohipparion niobrarense** sp. nov.

Type. Anterior portion of skull with lower jaws (No. 10828), from the vicinity of Fort Niobrara, Nebraska.

This specimen represents a species but little larger than *N. gratum* and differing from it in the following characters:

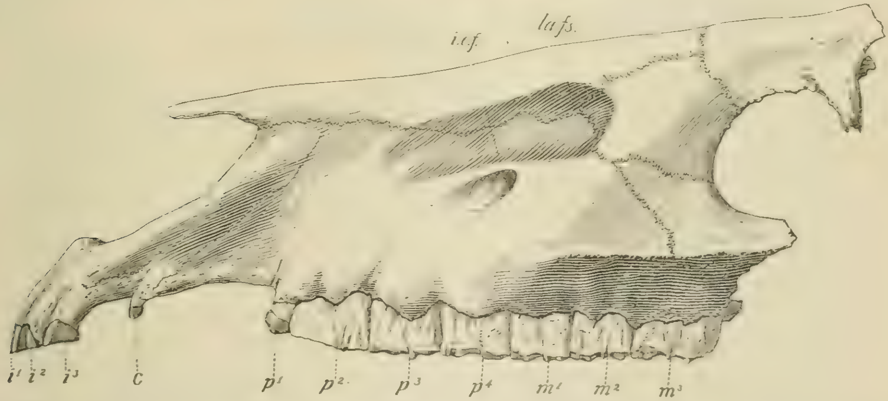


Fig. 18.—*Neohipparion niobrarense* sp. nov. Anterior part of skull, half natural size. Type specimen, No. 10828, Loup Fork formation, near Fort Niobrara, Nebraska. *I. o. f.*, infraorbital foramen; *la. fs.*, lachrymal fossa.

(1) The skull, especially in the nasal and premaxillary region, is longer and narrower; (2) the palate is narrow and more arched; (3) the anterior palatine foramina are more open but do not extend as far

backward as in *N. gratum;* the posterior palatal notch apparently extends as far forward as the middle of m^1; (4) the malar fossa is wanting; (5) the lachrymal fossa is larger, extends farther backward, and has a rather sharply defined posterior border; the lower jaws correspond in relative length and width with the skull; (6) the symphysis is longer and narrower than in *N. gratum* but is not so extreme in proportions as in *N. dolichops;* and (7) the ramus is bowed as in *N. gratum* but has a less vertical depth.

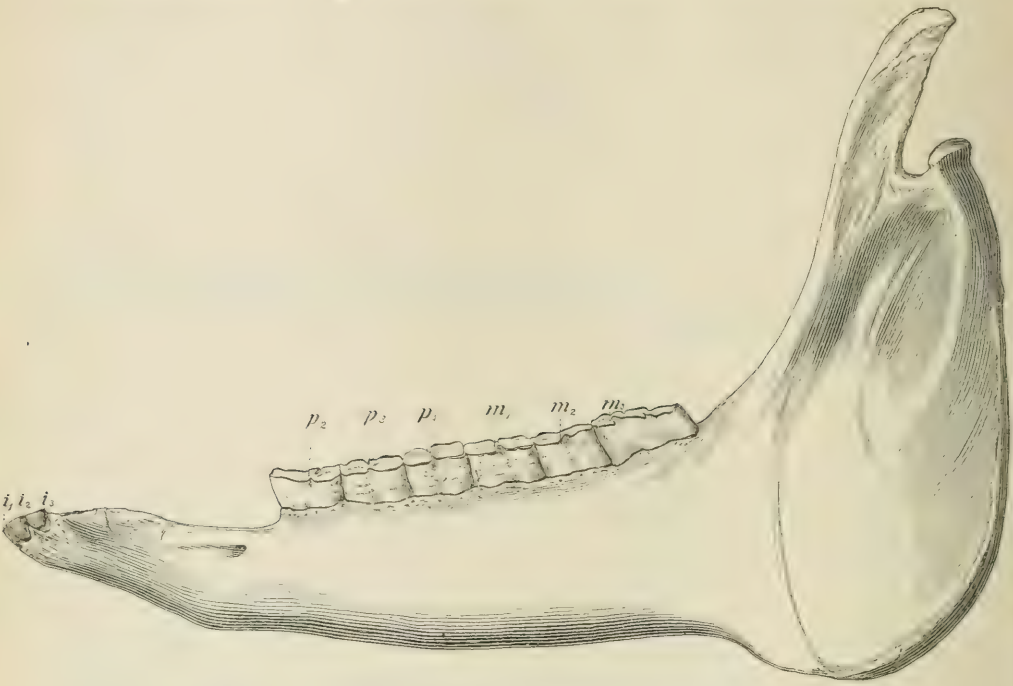


Fig. 19.—*Neohipparion niobrarense.* Lower jaw of type, half natural size, external view.

The type specimen is of a very old individual with the tooth characters practically obliterated by wear. The skull and jaw characters, therefore, form the basis of its generic reference.

In a lot of upper teeth in the United States National Museum, referred by Leidy to his "*Hipparion speciosum,*" there are several specimens which agree in size with the teeth of *N. niobrarensis.* These specimens are clearly of the Neohipparion pattern and are possibly referable to this species.

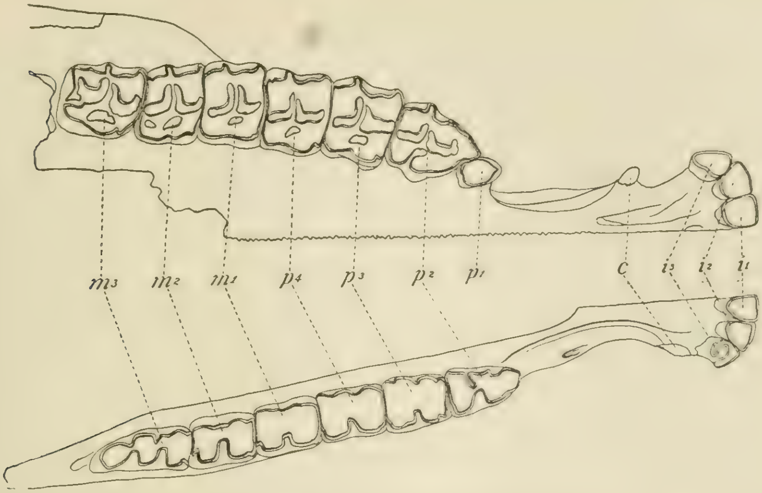


Fig. 20.—*Neohipparion niobrarense.* Upper and lower dentition, half natural size. Type specimen. No. 10828.

Measurements of Type (No. 10828).

	Antero-post.		Transv.	
Diameters of p^1	11	mm.	7	mm.
" " p^2	22	"	19.5	"
" " p^3	16.8	"	21.8	"
" " p^4	17	"	21.5	"
" " m^1	16.5	"	20.5	"
" " m^2	16.4	"	20	"
" " m^3	21	"	19	"

Skull.

Total length of molar-premolar series including p^1	117	mm.
Total length of molar-dental series, m^3 to i^1	185	"
Length of diastema between p^1 and i^3	53	"
Width of palate between first molars	38	"
Width of palate between second premolars	27.5	"
Width of palate in front of first premolars	21	"
Width of incisive border	28	"
Height of skull above m^1	86	"
Distance from orbit to anterior narial notch	115	"

Lower Jaw.

Total length of jaw	265	"
Length of complete dental series m_3 to i_1	185	"
Length of molar-premolar series	110	"
Length of diastema between p_2 and i_3	52	
Width of symphysis at narrowest point	21	"
Width across incisive border	34	"
Depth of jaw at m_1	53	"
Height of condyles above bottom of jaw	140	"

56.81,3(1181:78.7)

Article IX.—ON TWO INTERESTING GENERA OF EOCENE TURTLES, CHISTERNON LEIDY AND ANOSTEIRA LEIDY.

By Oliver P. Hay.

The genus *Chisternon* was proposed in 1872 by Dr. Joseph Leidy (Proc. Acad. Nat. Sci. Phila., p. 162) for the reception of his earlier described *Baëna undata*. The character which led Dr. Leidy to found the genus was the presence of a pair of mesoplastral bones. At that time the presence of the same bones in *Baëna arenosa*, the type of the genus *Baëna*, had not yet been observed. When these had been discovered in the species just mentioned, by Cope, in 1884, there appeared to be no reason for retaining *Chisternon*.

Recently the writer has been studying the species of the Baënidæ, and he has found, as he thinks, sufficient reasons for reviving Leidy's *Chisternon*.

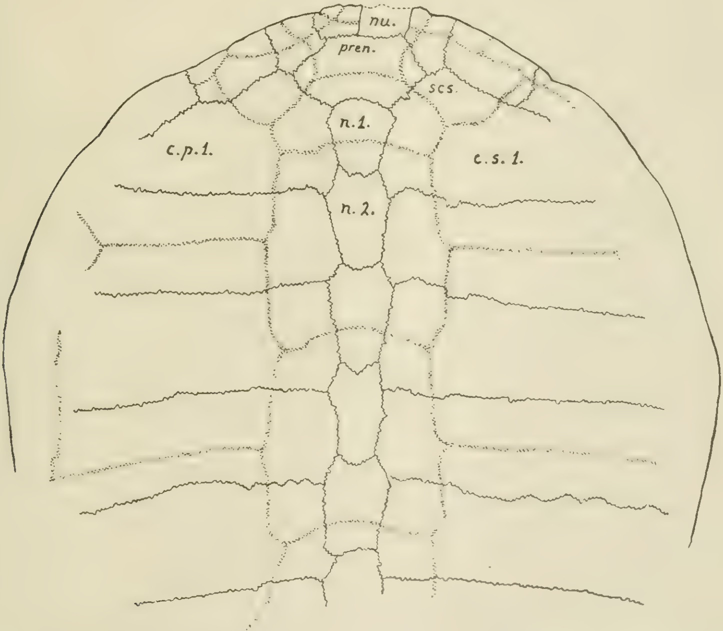


Fig. 1.—*Chisternon hebraicum* Leidy. Portion of carapace. *c. p. 1.*, first costal plate; *c. s. 1.*, first costal scute; *n. 1. n. 2.*, first and second neurals; *nu.*, nuchal bone; *pren.*, preneural; *scs.*, supernumerary costal scute.

In such specimens of *Baëna* as have not the sutures wholly obliterated by coössification of the bones it is seen that the nuchal bone is followed immediately by the first neural, the normal condition in the vast majority of turtles, living and extinct. In *Chisternon undatum* and *C. hebraicum* a different condition prevails. Figure 1 represents a portion of a large carapace of *C. hebraicum* which was secured in the Bridger beds of Grizzly Buttes, Wyoming, in 1903. This carapace was accompanied by the complete plastron and a fine skull. Figures of this skull have been published by the writer (Bull. Amer. Mus. Nat. Hist., XXI, 1905, pp. 138, 139, figs. 1–3) under the name *Baëna undata.* This was done before the writer had observed the differences between *Chisternon* and *Baëna* and those between the two species of *Chisternon.*

In the carapace here figured the sutures between the bones are all open and easily traced. In Figure 1 the sutures are represented by the zigzag lines; the boundaries between the horny scutes, by the dotted bands. It will be observed that the nuchal bone, only half of which is present, is very narrow from front to rear. Immediately behind it comes a large hexagonal bone; and this is followed in turn by the first neural. No bone exactly like the one behind the nuchal is known in any other genus of turtles, and its presence is regarded as of generic importance. In this genus are included the two species already mentioned, *C. undatum* and *C. hebraicum.* As already noted by Prof. Cope, these species attain a larger size than do the species of *Baëna*, and the bones become consolidated at a later period of life.

Notwithstanding the relatively large size of the bone behind the nuchal of *Chisternon*, it is not believed to be wholly new among turtles. In three living species of the soft-shelled turtles, the Trionychidæ, *Trionyx gangeticus*, *leithii*, and *hurum*, of Boulenger's 'Catalogue of Chelonians,' there are, between the proximal ends of the costals of the first pair, what have been called two neurals. On this character the writer has proposed the genus *Aspideretes*, with *T. gangeticus* as type (Proc. Amer. Philos. Soc., XLII, 1903, p. 274). The anterior of these two bones he has called a preneural. It is found in a considerable number of fossil species of this family. It is present also in the trionychoid genus *Plastomenus*. It is held that the presence of this bone is a primitive character.

Furthermore, a similarly placed bone has recently been found in a species of the Baënidæ. Not long ago Mr. L. M. Lambe published and figured *Baëna pulchra* from the Judith River deposits of Alberta, (Ottawa Naturalist, XIX, 1906, p. 189, pl. iii, fig. 4). Between the nuchal and the first neural is seen a short bone, as wide as the neural; and this must be the homologue both of the preneural of the soft-shelled turtles and of *Chisternon*. *B. pulchra* certainly is the representative of a new genus and has been more recently published as such. (*Boremys*, Ottawa Naturalist, XIX, p. 232.) It appears reasonable to conclude that all the genera which possess this preneural have inherited it from common ancestors of a much earlier time.

In the figure of the carapace of *Chisternon* it will be observed that there is a supernumerary costal scute on each side, such as is found in the living loggerhead turtle. This is not uncommon in the Baënidæ. Besides this, in *Chisternon* there is a supernumerary vertebral scute which occupies most of the area of the preneural and a portion of the nuchal.

One of the most beautiful of fossil turtles is *Anosteira ornata*, of the Bridger Eocene. A figure of a moderately well preserved specimen was published by Dr. Leidy in his 'Contributions to the Extinct Fauna of the Western Territories,' plate xvi. The systematic position of this genus has been very doubtful. Dr. Leidy regarded it, with *Baëna*, *Chisternon*, and *Baptemys*, as intermediate to the Pleurodira and the snapping turtles, Chelydridæ. Cope arranged

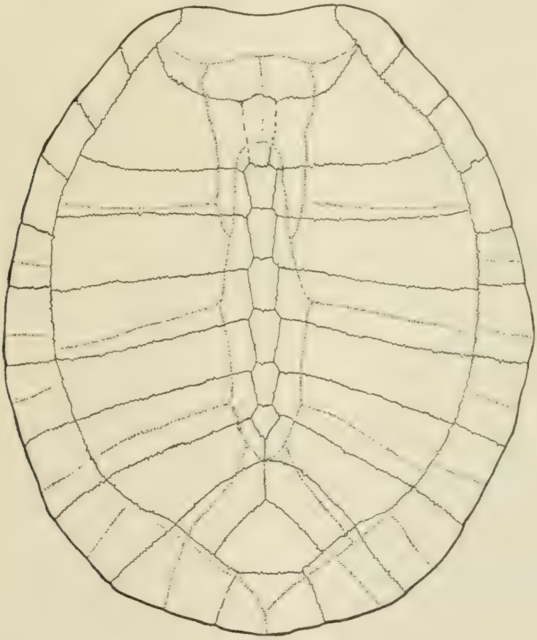


Fig. 2.—*Anosteira ornata* Leidy. View of Carapace. × $\frac{2}{3}$

it among the members of the family last mentioned. Lydekker places the genus in the subfamily Anosteirinæ, a division of the Chelydridæ. Baur believed that it belonged either with the Staurotypidæ (which he separated from the Dermatemydidæ), or with the Kinosternidæ.

During the past summer the American Museum expedition to the Bridger basin obtained at Henry's Fork a nearly complete specimen of this species. It lacked only the neurals, a part of the left side, and a fragment of one epiplastron. From this specimen mainly has been constructed Figures 2 and 3. From Figure 3 it will be seen that the entoplastron is present. Most of the bones of the plastron are joined by rather loose sutures. The plastron resembles closely that of *Staurotypus salvinii*, but in the latter the bones are joined by very jagged sutures. There can now hardly be any doubt that *Anosteira* belongs near *Staurotypus* and *Dermatemys*, genera confined to Central America.

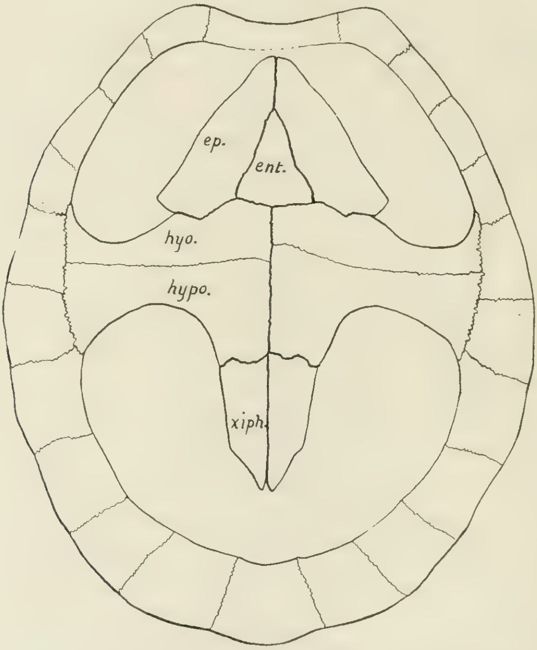


Fig. 3.—*Anosteira ornata* Leidy. View of plastron. $\times \frac{2}{3}$. *ent.* entoplastron ; *ep.*, epiplastron ; *hyo.*, hyoplastron ; *hypo.*, hypoplastron ; *xiph.*, xiphiplastion.

Some extremely interesting structures are to be observed on the carapace. Hitherto little has been known regarding the horny scutes. Dr. Baur showed that on some of the bones there were traces of the sulci. In the specimen figured here most of the scute areas can be determined. Mainly on account of the sculpture, the nuchal and the anterior marginal scutes cannot be mapped out. The vertebral scutes are strangely modified. Usually in turtles a sulcus crosses the first neural and divides the first from the second vertebral scute. In *A. ornata* there is no trace of this sulcus. The sulcus between the second and the third vertebral scutes starts on each side as usual; but instead of crossing on the third neural, it is carried forward and crosses on the first neural. The explanation of this condition appears to be that the first and second vertebrals have coalesced and the third has been pushed forward medially as far as the original boundary between the first and second. This arrangement has been observed on two specimens of the species. Furthermore, a median sulcus starts at the front of the first vertebral and runs backward to the hinder border of the nuchal bone The first neural not being preserved, it is impossible to say whether or not the sulcus continued backward to the loop referred to above. It probably did. In that case, the coalesced first and second vertebrals would be divided into right and left halves.

Also, the third and the fourth vertebrals appear to have coalesced; for no trace can be found of a sulcus crossing the fifth neural, where it is to be expected.

At the rear of the carapace may be seen the sulci bordering the marginal scutes above, but these cannot be seen along the sides and in front. Probably they followed closely the costo-peripheral sutures.

No traces are to be found of sulci on the plastral bones. No doubt these too were covered by horny scutes, but they must have been thin and delicate and they left no impressions on the bones.

The nuchal bone of this genus possesses no costiform processes, such as are to be seen in *Staurotypus*. Nevertheless, the writer does not hesitate to place *Anosteira*, *Staurotypus*, and *Dermatemys* in the same family. The genera *Adocus* and *Agomphus* are to be associated with them. *Pseudotrionyx* Dollo of the Middle Eocene of Belgium, without doubt, is closely related to *Anosteira*. In some of these the costiform processes may be regarded as either rudimentary or vestigial. The writer does not believe that the primitive turtles possessed these processes.

Anosteira anglica has been described by Mr. R. Lydekker from the Oligocene of England. The specimens figured resemble more *Pseudotrionyx delheidi* Dollo, of the Middle Eocene of Belgium.

There can be no doubt that *Pseudotrionyx* is closely related to *Anosteira.*

In a review of Lydekker's 'Catalogue of Fossil Reptiles' Prof. Cope, in 1891 (Amer. Naturalist, XXV, p. 645), assumed that the family name Dermatemydidæ had been proposed by Lydekker, in 1889. This was an error. The name Dermatemydæ was used by Gray in his 'Supplement to the Catalogue of Shield Reptiles,' 1870, page 49. As this was probably issued before Cope's paper in which he used the name Adocidæ, it is incumbent to employ Gray's term.

This paper is published with the consent of the Carnegie Institution of Washington.

59.82 (72.4)

Article X.—LIST OF BIRDS COLLECTED IN NORTHWESTERN DURANGO, MEXICO, BY J. H. BATTY, DURING 1903.

By Waldron De Witt Miller.

The collection of birds forming the basis of the present paper was made for the Museum by Mr. J. H. Batty, in the northwestern part of the State of Durango, Mexico, between Jan. 19, 1903, and Nov. 26, 1903. It numbers 829 specimens, representing 132 species. The principal localities, with the dates of collecting at each, are as follows[1]: (1) Rosario, altitude 7500 feet, on the Rio Florida, at the terminus of the Parral branch of the Mexican Central Railroad; Jan. 19–26. (2) Las Bocas, a dry river bottom on the Rio Florida, altitude 6800 feet; Feb. 5–11. (3) Rancho Santuario, an old "Spanish Grant" ranch, on the plains, altitude 7000 feet; Feb. 6–22. (4) La Boquilla, a pass in the San José Mountains, at 7000 feet; Feb. 12–14; (5) Villa Ocampo, or Ville de Campo, a few miles below Las Bocas, on the Rio Florida, altitude 7000 feet; Feb. 18–19. (6) Matalotes, at the head of the Arroyo Matalotes, at the base of the Sierra Madre, altitude 8000 feet; March 22–26. (7) Cienega de las Vacas, at the base of Sierra Madre, altitude 8500 feet; March 25–April 6. (8) Rio Sestin. one of the most fertile valleys of the region, altitude 7500 feet; April 4–21, May 3 and 4. (9) Rancho Baillon, in the foot-hills of a small range of mountains overlooking the Sestin Valley from the east, altitude 7800 feet; May 5–13, 21–24. (10) Arroyo del Buey, a deep, rocky cañon in the Sierra del Candella, altitude 7500 feet; May 21–29. (11) Guanacevi, altitude 8000 feet; Oct. 9–13. (12) San Andres, altitude 7000 feet; Nov. 2–13. (13) Sayupa, on the Sinaloa boundary, altitude 2500 feet, Nov. 21–26.

In the case of several species, the Durango birds are almost exactly intermediate between the representative subspecies of the southwestern United States and that of central Mexico and cannot properly be referred to either. In most of these cases, however, one or more of the specimens of the series show a leaning to one form or the other, and I have accordingly recorded them under the name of that subspecies, although the majority of the birds of the series may be as near the other form. The notes will in each case explain

---

[1] In describing these localities, I have made use of Dr. J. A. Allen's paper on the mammals collected in the same region, this Bulletin, Vol. XIX, 1903, pp. 590, 591.

[June, *1906*]

the exact status of such intermediate forms. These species are as follows:

Cyrtonyx montezumæ.
Icterus bullocki.
Junco phæonotus.
Pipilo fuscus.
Tachycineta thalassina.

The collector's field notes, giving the colors of the bill, feet, eyes, and other information, are distinguished by being enclosed in quotation marks. All measurements are in millimeters.

I wish to express my indebtedness to Mr. E. W. Nelson of the Biological Survey for assistance in identifying several species.

1. **Querquedula cyanoptera** (*Vieill.*).—Two males, Rancho Baillon, May 9. "Rather common. Said to breed in May."

2. **Butorides virescens anthonyi** (*Mearns*).—One specimen, Rio Sestin, May 3. "Common. Arrives in April. Breeds in May."

3. **Fulica americana** *Gmel.*—Three specimens: Matalotes, 2 specimens, March 23; Rio Sestin, 1 specimen, April 14. "Not common" at Matalotes.

4. **Numenius longirostris** *Wils.*—One specimen, Rancho Santuario, Feb. 22. "Common in flocks on dry hills."

5. **Oxyechus vociferus** (*Linn.*).—Three specimens; Rio Sestin, 1 specimen, April 9; Rancho Baillon, 2 specimens, May 6. "Rather common. Breeds" at former locality. "Common. Breeds in April and May. Steady resident" at latter place. One of the May specimens is a young bird in downy plumage.

6. **Lophortyx douglasi douglasi** (*Vig.*).—One specimen, a female, Casa Blanca (alt. 1000 feet), date not given.

7. **Callipepla squamata squamata** (*Vig.*).—Eleven specimens, Rancho Baillon, May 5–13. "Rather common. Breeds in April and May."

8. **Cyrtonyx montezumæ mearnsi** *Nels.*—Eight specimens: Paraje de las Mujeres, 3 specimens, May 21; Arroyo del Buey, 1 specimen, May 28; San Juan (alt. 2000 feet), 3 specimens, Nov. 21; San José (8000 feet), 1 specimen in fall plumage. The collector's notes on the last specimen are as follows: "Iris dark hazel. Feet pale whitish blue, claws bluish white. Upper mandible dark horn, lower mandible bluish white. Breeds."

With the exception of the San José Mts. specimen, which is nearly typical of *mearnsi*, these specimens are intermediate between *montezumæ* and *mearnsi*, and are perhaps as near one as the other. All, however, have the crest fully as pale as in typical *mearnsi*. Two of the November specimens are in juvenal plumage, with the first feathers of the winter plumage appearing.

In the size of the white spots on the sides, in the shade of the upper parts, and in other respects, there is great variation in specimens of *mearnsi* from the southwestern United States (Texas and Arizona).

9. **Ortalis wagleri** *Gray.* — One specimen, Sayupa (2500 feet) Nov. 21.

10. **Scardafella inca** (*Less.*).—Three specimens: La Boquilla, Feb. 12; Rio Sestin, May 3 and 4. "Common. Breeds in May. Steady resident. Iris brownish red. Feet pale flesh color. Bill black. Base of lower mandible bluish white" (refers to the May 4th bird, an adult female).

11. **Melopelia leucoptera** (*Linn.*).—Six specimens: Las Bocas, 1 specimen, Feb. 8; La Boquilla, 1 specimen, Feb. 14; Rio Sestin, 4 specimens, May 3. "Iris reddish orange. Feet magenta. Bill black. Common. Breeds in early part of May" (Rio Sestin).

12. **Zenaidura macroura macroura** (*Linn.*).—Three specimens: Rio Sestin, 1 specimen, April 9; Cienega de las Vacas, 2 specimens, March 31.

13. **Columba fasciata fasciata** *Say.*—One specimen, La Cienega (alt. 7500 feet), no date given.

14. **Cerchneis sparveria phalœna** (*Less.*).—Five specimens: Rio Sestin, 2 specimens, April 9 and May 3; Santa Rosalia (8000 feet), Nov. 1. "Very common. Breeds," at first-named locality.

The first two specimens, both males, measure, respectively: wing 185 mm., tail 127; wing 197, tail 132 (but would be about 136 if unworn).

15. **Asturina plagiata** *Schlegel.*—One specimen, La Cienga (7500 feet), Nov. 1.

16. **Urubitinga anthracina** (*Licht.*).—Two specimens, Rio Sestin, April 16 and 17. "Common. Breeds."

17. **Buteo swainsoni** *Bonap.*—One specimen, Rio Sestin, April 7. "Common. Breeds."

18. **Buteo borealis calurus** (*Cass.*).—Two specimens, San Andres (7000 feet), Nov. 9 and 13.

19. **Megascops asio aikeni** *Brewst.*—Three specimens: Santuario, Feb. 22; Rio Sestin, April 4 and May 3. "Common" at Santuario. "Rather common steady resident. Breeding" at Rio Sestin, May 3.

These specimens, which I refer provisionally to *aikeni*, differ greatly from a series of Arizona (Fort Verde) specimens of *cineraceus* in having the upper parts grayer, with the streaks broader, blacker, and more sharply defined. They closely resemble a bird from Vado, New Mexico, and also a specimen from Fort Wingate, New Mexico, labeled *aikeni* by Dr. J. A. Allen. If inseparable from *aikeni*, the known range of this subspecies is thus extended several hundred miles southward.

20. **Megascops trichopsis** (*Wagler*).—One specimen Rio Sestin, April 14. "Iris pale yellow."

21. **Asio wilsonianus** (*Less.*).—Three specimens, Las Bocas, Feb. 8 and 9.

22. **Rhynchopsitta pachyrhyncha** (*Swains.*).—Three specimens: Arroyo del Buey, May 28 and 29; San Andres (7000 feet), Nov. 13. Male and female, May: "Iris brownish red. Feet brownish black. Bill solid bluish black. Rather common. Frequents high mountains, pine lands, and oak woods."

23. **Geococcyx californianus** (*Less.*). — Fourteen specimens: Rio Sestin, 1 specimen, April 10; Rancho Baillon, 9 specimens, May 5-13; Arroyo del Buey, 1 specimen, May 28; Rio Campo, 2 specimens July 29 and 30; Guanacevi (8000 feet), 1 specimen, Oct 11. At Rancho Baillon a "rather common steady resident. Breeds." One specimen, dated May 13, is a young bird, not fully fledged.

24. **Trogon ambiguus** *Gould.*—One specimen, Arroyo del Buey, May 28.

25. **Ceryle americana septentrionalis** *Sharpe.*—Four specimens: Rosario, Jan. 26; Santuario, Feb. 6; Las Bocas, Feb. 10; Rio Sestin, April 9. Male, April 9, "iris hazel. Steady resident. Breeds in May."

26. **Ceryle alcyon** (*Linn.*).—Four specimens: Santuario, 3 speci-

mens, Feb. 7 and 16; Sayupa (2000) feet, 1 specimen, Nov. 21.

27. **Colaptes cafer collaris** (*Vig.*).—Twenty-six specimens: Rosario, 10 specimens, Jan. 19–21; Rancho Santuario, 1 specimen, Feb. 22; La Boquilla, 2 specimens, Feb. 13 and 14; Las Bocas, 7 specimens, Feb. 8 and 11; Cienega de las Vacas, 3 specimens, March 26; Rio Sestin, 1 specimen, May 3; Arroyo del Buey, 2 specimens, May 28. Rio Sestin, May 3. "Common. Breeds. Steady resident."

These specimens average about 6 mm. shorter in length of wing than a series of Arizona birds, in respect to size approaching the smaller and darker southern form, typical *cafer*. In color, however, they are even further from *cafer* than are the Arizona specimens.

Compared with the latter, the upper parts average distinctly paler and grayer—less tawny brownish, and compared with California birds, the difference is still greater. As there is considerable variation, however, in the exact shade of the upper parts, I do not think it is advisable to separate the Durango birds subspecifically.

The May specimen, a male, has a number of red-tipped nape feathers, also several on the extreme forehead and one in the supraloral region.

28. **Centurus aurifrons** (*Wagl.*).—Thirty-five specimens: Rosario, 8 specimens, Jan. 19–26; Santuario, 3 specimens, Feb. 6; Las Bocas, 6 specimens, Feb. 8-11; Ville Bocas, 1 specimen, Feb. 12; La Boquilla, 7 specimens, Feb. 13 and 14; Villa Ocampo, 1 specimen, Feb. 18; Cienega de las Vacas, 1 specimen, April 6; Rio Sestin, 6 specimens, April 9–May 4; Rancho Baillon, 2 specimens, May 5.

This species is stated by the collector to be a "common steady resident, breeding in May. Breeds mostly in cottonwood bottoms." Of the April and May specimens, the iris is given as "brownish red" or "reddish brown," the feet as "bluish apple green" or "whitish apple green" and the bill as "black" or "bluish black."

Several of these specimens exhibit the peculiar conditions of plumage mentioned by Mr. Brewster[1] the black areas of parts of the wings and tail-feathers, and of the back in one bird, being replaced irregularly with pale brown.

One specimen, female, Jan. 20, has a single orange red feather in the center of crown.

29. **Melanerpes formicivorus formicivorus** (*Swains.*).—Twenty specimens: La Cienega de las Vacas, 3 specimens, March 26 and 31;

---

[1] Birds of the Cape Region of Lower California, p. 106.

Rio Sestin, 6 specimens, April 9–17; Arroyo del Buey, 11 specimens, May 22–28. "Rather common. Migratory, first seen in April. Said to breed" (Rio Sestin).

30. **Sphyrapicus varius nuchalis** *Baird.*—One specimen, La Cienega de las Vacas, March 31. This is a female, with lower part of throbt red.

31. **Sphyrapicus thyroideus** (*Cass.*).—One specimen, Las Bocas, Feb. 11.

32. **Dryobates villosus hyloscopus** (*Cab.*).—One specimen, an adult female, Arroyo del Buey, May 28.

This specimen differs from California and Arizona birds in having the white markings of head and back somewhat more restricted, the white wing spots slightly smaller, the black marks on sides of breast larger, the bill considerably shorter (exposed culmen 22.5 mm.), and the feet smaller. The wing, which is somewhat worn, measures 120.6. Additional specimens may show the desirability of separating the birds of this region from *hyloscopus*.

33. **Dryobates scalaris bairdi** (*Scl.*).—Eight specimens: Rosario 1 specimen, Jan. 20; Las Bocas, 2 specimens, Feb. 10; La Cienega de las Vacas, 3 specimens, March 30 and April 1; Rio Sestin, 1 specimen, April 10; Rancho Baillon, 1 specimen, May 5.

These birds are a darker, smokier shade below than a series of Arizona specimens.

34. **Dryobates arizonæ arizonæ** (*Hargitt.*).—Eight specimens: Matalotes, 1 specimen, March 23; La Cienega de las Vacas, 6 specimens, March 30–April 3; Arroyo del Buey, 1 specimen, May 23. "Iris hazel. Rather common" at Cienega de las Vacas.

35. **Chordeiles acutipennis texensis** (*Lawr.*).—One specimen, Rancho Baillon, May 9. "Iris dark hazel. Feet pale whitish brown. Bill solid black."

This specimen, a male, measures, wing 188, tail 111. The *maximum* length of wing given by Ridgway, in his Manual, is (converted into millimeters) 185. Of the sixty-two adult specimens, mostly from Texas and Arizona, constituting the Museum series, only three, all males, equal or exceed this bird in length of wing, the localities and measurements being as follows: Lomita, Texas, 188; Tucson, Arizona, 190; Jalapa, Vera Cruz, 189.

36. **Antrostomus vociferus macromystax** (*Wagl.*).—Two specimens, Arroyo del Buey, a female, May 22, and a male, May 28. "Entire eye bluish white. Stomach [of female] contained large beetles."

37. **Calothorax lucifer** (*Swains.*).—Six specimens, males and females, Rancho Baillon, May 10–23. "Iris hazel. Rather common. Breeds in May."

38. **Selasphorus platycercus** (*Swains.*).—One specimen, an immature male, Guanacevi, Oct. "Iris hazel."

39. **Trochilus alexandri** *Bourc. and Muls.*—One specimen, a female, Rio Sestin, April 10. "Common. Arrives in April."

40. **Cœligena clemenciæ** *Less.*—Twenty-seven specimens (22 males and 5 females): Rancho Baillon, 1 specimen, May 21; Arroyo del Buey, 26 specimens, May 22–28. "Iris hazel."

Careful measurements of 13 males and the 5 females of the series and 2 additional females reveal the fact that the sexes differ considerably in proportion, the females having shorter wings and tails, but longer bills than the males.

Males: wing, 74.2–80 (76.9); tail, 46.1–49.5 (47.6); bill, 22.1–24.7 (22.9).
Females: wing, 70.–73.6 (71.3); tail, 43.5–45.7 (44.9); bill, 24.8–27.5 (25.6).

41. **Eugenes fulgens** *Swains.*—Six specimens, all males: Arroyo del Buey, 5 specimens, May 22–29; Rancho Baillon, 1 specimen, May 24. "Iris hazel."

One specimen has the throat of a decided *bluish* green, but is otherwise typical.

42. **Pyrocephalus rubineus mexicanus** (*Scl.*).—Eight specimens: Villa Ocampo, 1 specimen, Feb. 18; La Cienega de las Vacas, 2 specimens, April 2; Rio Sestin, 5 specimens, April 10–13. "Common. Arrives in March. Breeds in May."

43. **Empidonax traillii traillii** (*Aud.*).—One specimen, Rio Sestin, May 4. "Common. Arrives in April. Breeds in May."

44. **Empidonax wrightii** *Baird.*—Two specimens, Rio Sestin, April 9 and 10. "Common. Arrives in April."

45. **Empidonax canescens** *Salv. and Godm.*—One specimen, Villa Ocampo, Feb. 19.

46. **Empidonax pulverius** *Brewst.*—One specimen, Cienega de las Vacas, April 3. Identified by Mr. E. W. Nelson.

47. **Empidonax fulvifrons pygmæus** (*Coues*).—One specimen, Cienega de las Vacas, April 3.

48. **Horizopus pertinax pallidiventris** (*Chapm.*).—One specimen, Arroyo del Buey, May 27. Agrees with Arizona specimens, but is a trifle darker below than the average.

49. **Horizopus richardsonii richardsonii** (*Swains.*).—Two specimens, Rancho Baillon, May 6 and 9. "Rather common. Arrives last of April."

50. **Sayornis saya** (*Bonap.*).—Five specimens: Rosario, 1 specimen, Jan. 19; Las Bocas, 2 specimens, Feb. 10; Villa Ocampo, 1 specimen, Feb. 19; Rio Sestin, 1 specimen, May 4. "Rather common steady resident. Breeds in May" (Rio Sestin).

One specimen, a female, Las Bocas, Feb. 10, has the throat, breast, and especially the upper parts considerably darker than in the other specimens and also darker than in any of a series of birds from Texas, Arizona, California, etc. These parts do not show the brownish tinge of many specimens.

51. **Sayornis nigricans nigricans** (*Swains.*). — Two specimens Cienega de las Vacas, April 2.

52. **Myiarchus lawrencei olivascens** *Ridgw.* — Two specimens, Rio Sestin, April 11. "Common. Arrives in April. Breeds in May."

53. **Myiarchus cinerascens cinerascens** (*Lawr.*).—Eleven specimens, Rio Sestin, April 9–May 3. "Common. Arrives in April. Breeds in May."

54. **Tyrannus vociferans** *Swains.*—Thirteen specimens: Cienega de las Vacas, 1 specimen, April 5; Rio Sestin, 11 specimens, April 7–May 4; Rancho Baillon, 1 specimen, May 10. "Very common. Arrives in April. Breeds in May."

55. **Otocoris alpestris aphrasta** *Oberh.*—Six specimens, five males and one female, Villa Ocampo, Feb. 18 and 19.

The five males exhibit considerable variation but are all undoubtedly referable to *aphrasta*. They differ from typical (Fort Verde, Arizona) specimens of *occidentalis* in somewhat paler and more uniform upper parts, the nape being slightly pinker, and the back less "scorched," the darker centers less conspicuous, especially on the rump. Their wings measure 101 to 107, average 104.2.

Although without a sufficiently large series to settle the question to my satisfaction, yet the desirability of recognizing *aphrasta* seems to me open to doubt. In comparing *aphrasta* with *occidentalis*, Mr. Oberholser says that the former is "decidedly smaller, as well as somewhat less deeply colored." The color differences are slight, however, especially when the large amount of individual variation is taken into account, and in the specimens before me the difference in size does not hold. The average wing measurements of three Fort Verde specimens with scarcely worn quills is 102.4, only .4 greater than the average of *aphrasta* as given by Mr. Oberholser and actually less than the Durango specimens.

56. **Cyanocitta stelleri diademata** (*Bonap.*).—Thirty-six specimens: La Cienega de las Vacas, 1 specimen, Mar. 26; Arroyo del Buey, 30 specimens, May 24–29; San Andres, 1 specimen, Nov. 3; Cienega Corales, 4 specimens, Nov. 3. "Common. Breeding" at Arroyo del Buey.

These birds are not separable from Arizona specimens. There is a slight average difference in color which is difficult to express in exact terms, and the size is slightly less. The Durango specimens appear to average a trifle lighter and grayer above. A series of 7 males and 8 females from Durango measure respectively in length of wing, 142–150 (average 145) and 136–141 (average 138.1), and a series of 8 males and 8 females from Arizona measure, 147–153 (148.6) and 137-146 (141.5). The wing of the southern specimens thus averages 3.5 mm. shorter than that of the northern birds. Mr. Ridgway has also called attention to these differences. With a series of only 4 specimens from Durango, Zacatecas, and Jalisco, he states that he does not favor the subspecific separation of the southern birds.

57. **Aphelocoma grisea** *Nels.*—Thirteen specimens: Rosario, 5 specimens, Jan 19–27; Santuario, 2 specimens, Feb. 16; Ville Bocas, 1 specimen, Feb. 12; Las Bocas, 3 specimens, Feb. 8 and 10; La Boquilla, 2 specimens, Feb 13 and 14.

Two of these specimens differ from the others in having the median chest feathers distinctly edged with pale blue. Measurements of the ten birds sexed as female by collector are as follows: wing, 126–138.5 (132.4); tail, 129.5–147.5 (137.4); exposed culmen, 23.5–25 (24.5) (eight specimens); tarsus, 33.4–40.3 (37.5). Only two of these have wing and tail measurements respectively over 135 and 139 and possibly are wrongly sexed. One specimen, marked male, measures, wing, 144; tail, 151.5; exposed culmen, 26; tarsus, 41.4. Two other specimens marked as males, but probably really females, measure, wing, 135 and 129.5; tail, 143.5 and 138; exposed culmen, 24 and 25; tarsus, 38.3 and 38.9. There is little doubt that *grisea* and *cyanotis* are not *specifically* distinct but as my specimens do not show actual intergradation, I leave *grisea* as a full species.

58. **Aphelocoma sieberii wollweberi** (*Kaup.*).—Twenty-three specimens: Las Bocas, 5 specimens, Feb. 8–10; La Boquilla, 2 specimens, Feb. 13; Cienega de las Vacas, 15 specimens, March 26–April 4; Arroyo del Buey, 1 specimen, May 25. "Very common; resident all the year; breeds."

59. **Calocitta colliei** (*Vig.*).—Two specimens: San Juan, 1 specimen, about Nov. 21; Sayupa, 1 specimen, Nov. 26.

I have called attention to the peculiarities of one of these birds in my report on Mr. Batty's collection from southern Sinaloa (this Bulletin, XXI, p. 359).

60. **Corvus corax sinuatus** (*Wagl.*).—Nineteen specimens: Rosario, 1 specimen, Jan. 27; Las Bocas, 4 specimens, Feb. 5–8; Villa Ocampo, 6 specimens, Feb. 11–19; La Boquilla, 3 specimens, Feb. 19; Santuario, 2 specimens, Feb. 20; Cienega de las Vacas, 1 specimen, April 6; Rio Sestin, 1 specimen, April 10. "Common. Breeds in April and May on cliffs and in trees" (Rio Sestin, April). "Common. Breeding" (Cienega de las Vacas, April).

61. **Megaquiscalus major macrourus** (*Swains.*).—Five specimens: Rosario, 3 specimens, without dates, but which must have been taken between the 15th and 30th of January; La Boquilla, 1 specimen, Feb. 12.

These specimens, 4 of which are immature males and 1 an adult male, are not typical *macrourus*, differing in somewhat smaller size. The adult measures: wing, 181.5, tail, 217, culmen, from base 37. The bill of this bird is doubtless, however, abnormally short, the tip being less attenuated than usual. The immature birds, with shorter wings and much shorter tails, have slightly longer bills, but all the dimensions are less than those of a comparable bird from eastern Mexico.

62. **Euphagus cyanocephalus** (*Wagl.*).—Four specimens: Rosario, Jan. 20; La Boquilla, Feb. 14; Rio Sestin, April 11 and 14.

The three males measure: wing, 128–131.5 (130.2); tail, 101.5–105 (103.7); exposed culmen, 20–21.4 (20.5); one female, wing, 114; tail, 87; exposed culmen, 17.

63. **Sturnella neglecta** *Aud.*—Eleven specimens: Rosario, 1 specimen, Jan. 27; Las Bocas, 2 specimens, Feb. 8; La Cienega de las Vacas, 3 specimens, March 25–27; Rio Sestin, 4 specimens, April 9–14. "Very common resident all the year; breeds" (Rio Sestin).

64. **Icterus bullockii bullockii** (*Swains.*).—Fourteen specimens: Rio Sestin, 12 specimens, April 11–May 4; Rancho Baillon, 1 specimen, May 6. "Common. Arrives middle of April. Breeds in May and June."

This interesting series of birds is intermediate between *Icterus bullockii* and *I. abeillei* which must therefore be merged into one species and known respectively as *Icterus bullockii bullockii* (Swainson) and *Icterus bullockii abeillei* (Lesson).

The series is, as a whole, much nearer *bullockii* than *abeillei*, one extreme being almost typical *bullockii*, the other about midway between the two forms, strongly suggesting *abeillei*. Most of the birds are nearer the *bullockii* end of the series.

Four specimens are nearly typical *bullockii* but the rump averages less orange and more heavily washed with olivaceous, and the flanks are more perceptibly washed with olivaceous. One of these four has the sides of head directly back of auriculars slightly washed with black.

The next three birds have the flanks tinged with *blackish*. One of them has sides of neck more extensively blackish, the black post-ocular stripe much broader and the orange supraciliary stripe shorter.

Two others have the rump tinged with blackish, more black on upper tail coverts and the black of interscapulum encroaching somewhat on rump. One of these has the forehead spotted with black. In the other the forehead, between the supraloral stripes, is solid black. The flanks are washed merely with olivaceous in these two birds.

The three remaining specimens are about half-way between *bullockii* and *abeillei*. The olivaceous of the rump is restricted and mixed with black. In one the forehead is entirely black, in the others much restricted and mixed with black. The black post-ocular stripe is broader. One has the supraciliary stripe very short (only 15 mm. long instead of 21 or more as in *bullockii*). In this bird the feathers of side of neck and of auriculars are conspicuously tipped with black. All three have sides of body strongly washed with black. The four specimens nearest *bullockii* average paler orange below. Two of the three nearest *abeillei* and most of the remaining birds average as orange as typical *bullockii.* Although there is a hiatus between *abeillei* and these specimens, there can be little doubt that specimens from somewhat further south would completely bridge this gap, and I have no hesitation in reducing *abeillei* to a subspecies.

65. **Icterus spurius** (*Linn.*).—Three specimens, all adult males, Rio Sestin, May 4. "Rather common. Arrives last of April. Breeds.

These specimens are doubtless breeding birds. They measure: wing, 77–80 (78.3); tail, 72.2–75.7 (73.5).

66. **Molothrus ater obscurus** (*Gmel.*).—Three specimens, Rancho Baillon, May 5. "Common. Arrives in March; breeds in May."

The two males measure: wing, 103.5–104.5 (104); tail, in both, 72.3; the female: wing, 91.5; tail, 62.5.

67. **Calamospiza melanocorys** *Stejn.*—One specimen, Rancho Baillon, May 12. "Rather common. Breeds in May."

68. **Guiraca cærulea lazula** (*Less.*).—Six specimens, Rancho Baillon, May 7–13. "Rather common. Breeds in May."

69. **Zamelodia melanocephala** (*Swains.*).—Three specimens, Arroyo del Buey, May 28 and 29.

70. **Pyrrhuloxia sinuata sinuata** *Bonap.*—Sixteen specimens: Rosario, 2 specimens, Jan. 26; Rancho Baillon, 10 specimens, May 5–10. "Rather common. Steady resident. Breeds in May."

These specimens do not appear to be typical *P. sinuata sinuata.* All have more or less dusky mixed in with red of loral, orbital, and malar regions. The upper parts, although pale, are grayer than in typical birds.

71. **Oreospiza chlorura** (*Aud.*).—Four specimens, Rio Sestin, April 11–16. "Common. Arrives in March."

72. **Pipilo maculatus megalonyx** (*Baird*).—One specimen, a male, Cienega de las Vacas, March 26. "Not very common."

This specimen is nearest *megalonyx* but shows a decided approach to true *maculatus.* The rump is distinctly browner than the brownest of a large series of Arizona birds, and the grayish brown margins to the interscapulary feathers are browner and broader. The measurements are as follows: wing, 87; tail, 101.5; exposed culmen, 13.1; tarsus, 27; hind claw, 11.1; length of white patch on outer rectrix, 33.

73. **Pipilo fuscus mesoleucus** (*Baird*).—Fourteen specimens: Rosario, 1 specimen, Jan. 19; Las Bocas, 1 specimen, Feb, 11; Matalotes, 2 specimens, March 23 and 24; La Cienega de las Vacas, 4 specimens, April 2 and 3; Rio Sestin, 2 specimens, April 11 and May 3; Rancho Baillon, 1 specimen, May 5; Arroyo del Buey, 3 specimens, May 22–27. "Common steady resident. Breeds in May."

I provisionally refer these birds to *mesoleucus*, but they are not typical of this subspecies. The color of the upper parts averages decidedly darker and less brownish, and the crown with the rufous brown duller and more restricted. According to Mr. Ridgway, *mesoleucus* reaches only into northern Sonora and Chihuahua, and the form from northwestern Durango should be *potosinus*, which reaches southern Chihuahua. These specimens appear to be on the whole nearer *mesoleucus*, however. Only one specimen has not a decidedly rufescent or reddish brown crown, and all have the relatively longer tail characteristic of the northern form. Four April specimens from Las Vigas, Vera Cruz (doubtfully referred by Mr. Ridgway in his synonymy to *potosinus*), are darker and browner above than the Durango birds, the crown *not* decidedly rufescent, the tail shorter.

74. **Melospiza lincolnii lincolnii** (*Aud.*).—Two specimens, Rio Sestin, April 11 and 17. "Common steady resident. Said to breed in May."

75. **Plagiospiza superciliosa** (*Swains.*).—Ten specimens, Arroyo del Buey, May 26 and 27. "Iris hazel."

76. **Aimophila ruficeps scottii** (*Sennett*).—Nine specimens: Rio Sestin, 2 specimens, April 11; Arroyo del Buey, 5 specimens, May 24–28; Cienega Corales (7000 feet), 1 specimen, Nov. 3. "Common steady resident. Iris hazel."

Compared with Arizona specimens, these birds have the upper parts duller, not such a light, bright *rusty* brown as in the more northern birds, and the under parts average whiter. There is, however, great variation, no two of the birds having the color of the upper parts precisely alike.

77. **Amphispiza bilineata grisea** *Nels.*—Fifteen specimens, Rancho Baillon, May 7–11. "Common, breeding. Frequents barren mesquite hills."

I have no specimen of *grisea* for comparison with these birds, and they may not be typical. They are much less brownish above than Arizona birds (*deserticola*), only one of them being distinctly brownish and closely resembling Arizona specimens. The wing measures 61.6–68.5 (av. 65.7), but only one less than 64.4.

78. **Junco caniceps** (*Woodh.*).—Six specimens, Cienega de las Vacas, March 30–April 3. "Iris hazel. Feet and bill brownish flesh" (male).

This species does not appear to have been previously recorded from further south than northeastern Sonora and northern Chihuahua.

79. **Junco phæonotus palliatus** *Ridgw.*—Two specimens, Arroyo del Buey, May 21 and 28. Male: "Iris light orange. Feet pale brownish white. Upper mandible dark horn, lower mandible brownish white." Female: "Iris hazel."

These birds are perfect intermediates between *phæonotus* and *palliatus*. In general coloration, they are very near the northern form but the head is appreciably darker gray than the average and the rump slightly tinged with olive. The extent of the white patches on the tail feathers, however, is similar to that of typical *phæonotus*.

80. **Spizella socialis arizonæ** *Coues.*—Five specimens: Villa Ocampo, Feb. 19; Matalotes, March 24; Rio Sestin, April 8; Arroyo del Buey, May 23; Guanacevi (young), Oct. 13. "Rather common. Arrives in March" (Rio Sestin).

These specimens agree in coloration with Arizona birds. The measurements of the three spring birds, a male and two females, are as follows: wing, 70–72.6 (71.7), tail, 61.6–63.1 (62.5). The February specimen, wing 76, tail 64.8. From the dates of the spring birds there can be no doubt that this species breeds in northern Durango, which is much further south than its breeding range has previously been known to extend.

81. **Spizella pallida** (*Swains.*).—Two specimens: Rosario, Jan. 26; Rancho Baillon, May 13. The following is noted on label of latter specimen, a female: "Feet pale whitish brown. Upper mandible reddish brown tipped with brownish black, lower mandible dark brownish flesh color." The date of this bird seems very late for a migrant.

The January specimen is paler and less heavily streaked than most United States birds but closely resembles two winter specimens from northern Sonora. Practically the only difference in coloration that I can see between such birds and some specimens of *Spizella breweri* is the greater brownness of the former, and the greater contrast between median and lateral crown stripes. United States birds almost invariably have the tail a trifle shorter than the wing but both of these Durango specimens have it slightly longer than the wing.

82. **Zonotrichia leucophrys leucophrys** (*Forst.*).—Four specimens: Rosario, 1 specimen, Jan. 26; Rancho Baillon, 3 specimens, May 7 and 10. "Rather common steady resident; said to breed in May."

83. **Chondestes grammacus strigatus** (*Swains.*).—Two specimens, Rancho Baillon, May 8 and 12. "Not very common."

84. **Coturniculus savannarum bimaculatus** (*Swains.*).—Two specimens, Rosario, one Jan. 19, the other without date.

85. **Poœcetes gramineus confinis** *Baird.*—Five specimens, Rosario, Jan. 19–26.

86. **Rhynchophanes mccownii** (*Lawr.*).—Five specimens, Villa Ocampo, Feb. 18.

87. **Spinus pinus pinus** (*Wils.*).—One specimen, Cienega de las Vacas, March 30.

88. **Astragalinus psaltria hesperophilus** *Oberh.*—Two specimens, a male and a female, Guanacevi, Oct. 13.

89. **Carpodacus mexicanus rhodocolpus** (*Cab.*).—Five specimens: Las Bocas, Feb. 10; La Cienega de las Vacas, March 30; Rio Sestin, April 17 and 18 and May 3. "Rather common steady resident. Breeding."

One of the two males is scarcely different from *C. m. frontalis.*

90. **Piranga hepatica** *Swains.*—Seven specimens: La Cienega de las Vacas, 1 specimen, March 26; Arroyo del Buey, 5 specimens, May 23 and 28; 1 without data. "Common, migratory. Arrives in April. Breeds in May."

91. **Piranga rubra cooperi** *Ridgw.*—Twenty-five specimens, all Rio Sestin, April 7–21. "Common. Migratory. Arrives in April. Breeds in May. Found principally in cottonwood bottoms."

Twenty-one are adult males, four are females. These specimens have somewhat smaller bills than typical examples of *P. r. cooperi*, but otherwise agree with this form.

92. **Stelgidopteryx serripennis** (*Aud.*).—Two specimens, Rio Sestin, April 15 and May 3. "Rather common; breeding" (on label of May bird).

In his 'Key' [1] to the species of *Stelgidopteryx*, Mr. Ridgway makes use of the color of the under tail coverts to distinguish *S. serripennis* from *S. ridgwayi*. The former is said to have the "under tail coverts entirely white"; in the latter they are described as "not entirely white, the two longer feathers having a terminal or subterminal spot of dusky or blackish."

Examination of the Museum series of *S. serripennis* shows that in this species the under tail coverts are not infrequently marked with more or less conspicuous spots of dusky, varying greatly in extent and intensity. Of the series of 59 specimens, 8 are thus marked. Five of these are from New York, one from Pennsylvania, one from Westminster Junction, British Columbia, and one from Rio Sestin, Durango (April 15). Of these 8 birds, 5 are marked male, and 3 female. Apparently, therefore, the variations in the color of the under tail coverts are purely individual.

93. **Tachycineta thalassina lepida** (*Mearns*).—Four specimens: Rio Sestin, 3 males, April 9 and 12; Arroyo del Buey, 1 female, May 29. "Common. Arrives in April."

With the exception of one of the males these specimens are nearly or quite typical *T. t. thalassina* in color, but agree in size with *T. t. lepida*.

The excepted male is on the whole nearer to *lepida*, agreeing with it in size and, to some extent, in color. The back is almost as green as that of the average *lepida*, but the upper tail coverts are less bluish than those of all, except possibly one or two, of a series of 29 specimens of the northern form.

The wing measurements of these specimens are as follows: ♀, 105; purplish-backed males, 108 and 117; greenish-backed male, 112.

94. **Hirundo erythrogaster** *Bodd.*—One specimen, Rio Sestin, April 13. "Common. Arrives in April. Breeds in May."

This specimen, a female, is an example of the dark type of western Barn Swallow. The middle and posterior lower parts are as dark below as those of any eastern United States male in the collection and are closely approached by only one out of the 17 eastern adult females. Other western females in the collection are as dark as this one, while some are as pale below as the average eastern female.

---

[1] Birds of North and Middle America, Part III, p. 57.

The differences between specimens from the opposite sides of North America seem to me not sufficiently constant to justify the recognition of *H. e. palmeri*.

The chestnut of the throat is fully as dark in the eastern as in the western birds. In 6 out of the 15 eastern adult males in the collection, there are very evident indications of the complete dark chest band seen in *H. rustica*, *i. e.*, traces of the upper as well as of the lower edge of this band. In none of the 14 western males before me is more than the lower edge of the band indicated, except on sides of chest.

95. **Petrochelidon lunifrons melanogaster** (*Swains.*).—Eight specimens, Rio Sestin, April 9–18. "Common, migratory. Arrives in April; breeds in May."

By the latest authority[1] the sexes in this subspecies are said to be alike, but the present series indicates a difference in this respect. In the three birds marked female, the forehead is decidedly paler than in the five other specimens, which are all marked male. In the female the forehead is scarcely if at all darker than the rump, while in the male it is much darker.

A series of 17 Cliff Swallows from Fort Verde, Yavapai Co., Arizona, (all but one taken in April or May) is intermediate between *P. l. lunifrons* and *P. l. melanogaster*, and must be referred to *P. l. tachina* with which they closely agree in both size and color. It is evident that the range of the latter subspecies must be extended from southwestern Texas to, at least, as far west as central Arizona.

Measurements of the wings of the Arizona specimens are as follows: male (7 specimens), 101–105 (av. 103.4); female (9 specimens), 99–107 (av. 103).

96. **Progne subis hesperia** *Brewst.*—One specimen, Arroyo del Buey, May 29. This is marked "♀" by the collector but is evidently[1] an immature male (first nuptial plumage).

According to the latest authority[2], *P. s. hesperia* is confined to the Pacific coast district. The Durango specimen, however, is a typical example of the paler form, having the under tail coverts pure white, and the forehead, fore crown, and collar conspicuously pale.

---

[1] Ridgway, Birds of North and Middle America, Part III, p. 51.

[2] Ridgway, Birds of North and Middle America, Part III, p. 35.

Dr. Mearns remarks[1] that "the status of the Arizona martin is unsatisfactory. Its measurements agree closely with those of *Progne subis hesperia* Brewster, except that the tarsus is slightly longer. In coloration its upper parts most resemble *hesperia*, its under parts *subis*." With the same specimens before me as were examined by Dr. Mearns, I fail to see that the Arizona birds are not unquestionably referable to *hesperia*. They certainly agree with the latter in the color of the under tail coverts, which appears to be the best if not the only real character of *hesperia*.[2] A single breeding female from western Texas (Fort Davis) is also referable to the paler form.

97. **Phainopepla nitens** (*Swains.*).—Nineteen specimens: Rosario, 1 specimen, Jan. 19; Las Bocas, 1 specimen, Feb. 11; Matalotes, 1 specimen, March 26; Rancho Baillon, 15 specimens, May 5–13, and (one) June 11. "Common steady resident. Breeds."

The measurements of the 9 adult males of this series are as follows: wing, 97.5–102.5 (100.3), tail, 98–106 (102.3). California specimens are much smaller, a series of 5 adult males measuring: wing, 90–93.5 (91.9); tail, 91–95.5 (93.4). Arizona birds are intermediate in size, but there is so much difference in the two extremes that it seems as if some division of the species would be desirable to emphasize this fact.

98. **Lanius ludovicianus excubitorides** (*Swains.*).—Eleven specimens: Rosario, 1 specimen, Jan. (15–30); Las Bocas, 3 specimens, Feb. 8 and 10; La Boquilla, 1 specimen, Feb. 13; Santuario, 1 specimen, Feb. 16; Rio Sestin, 1 specimen; Rancho Baillon, 4 specimens, May 6 and 10. "Common steady resident. Breeds."

The fact that four of these eleven specimens had one or more white feathers in the crown led to an examination of the entire Museum series of *Lanius ludovicianus*. The results seem to show that this species in all its forms has more than an ordinary tendency to partial albinism about the head. Of the 128 specimens examined, 22 possessed from one to three white feathers in the pileum, usually in front edge of crown, in a few cases in forehead, posterior edge of crown or in its lateral border.

99. **Vireo huttoni stephensi** *Brewst.*—Four specimens: La Cienega de las Vacas, 2 specimens, March 26 and 31; Arroyo del Buey, 2 specimens, May 23 and 24.

---

[1] Proc. U. S. Nat. Mus., 1902, p. 919.
[2] Cf. Dwight, Auk, 1905, p. 37.

100. **Vireo belli medius** *Oberh.*—One specimen, Rancho Baillon, May 8. Wing, 53.5; tail, 47.3.

101. **Lanivireo solitarius cassinii** (*Xantus*).—Two specimens: La Cienega de las Vacas, 1 specimen, March 29; Rio Sestin, 1 specimen April 10.

102. **Lanivireo solitarius plumbeus** (*Coues*).—Two specimens: Rio Sestin, April 13 and May 4. "Rather common."

103. **Setophaga picta picta** *Swains.*—Sixteen specimens: Las Bocas, 2 specimens, Feb. 11; Matalotes, 1 specimen, March 22; La Cienega de las Vacas, March 30–April 5; Rio Sestin, 3 specimens, April 8 and 9; Arroyo del Buey, 1 specimen, May 22. "Common. Arrives in March. Breeds in May."

104. **Wilsonia pusilla pileolata** (*Pallas*).—Two specimens: Rio Sestin, male, April 13; Rancho Baillon, female, May 6. The collector's note on the latter specimen gives this species as a breeder.

105. **Wilsonia pusilla chryseola** *Ridgw.*—One specimen: a male, Rio Sestin, May 3.

106. **Icteria virens longicauda** (*Lawr.*).—Three specimens: Rio Sestin, 2 males, May 3 and 4; Rancho Baillon, 1 male, May 13. "Arrives in May. Breeds."

107. **Geothlypis trichas occidentalis** *Brewst.*—Three specimens: Rio Sestin, April 9–12.

These specimens are not typical *occidentalis*, being larger. They are probably intergrades between *occidentalis* and *melanops*. Their measurements are as follows: wing, 60.5; tail, 61; w., 60.5; t., 58; w., 58.5; t., 58. The smallest specimen is a very rich orange yellow below, being unequaled in this respect by any one of the series of about 80 male western Yellow-throats now before me. The feathers of the vertix and the occiput are more or less extensively yellow beneath the surface, and the sides of the neck are also yellowish.

108. **Geothlypis trichas arizela** *Oberholser.*—One specimen, an adult male, Rio Sestin, April 11.

I refer this specimen to *arizela* rather than to *occidentalis* chiefly on account of the very narrow whitish head band. The band is decidedly tinged with gray and is oblique, owing to the unsymmetric form of the black mask. The measurements of this bird are: wing, 57; tail, 54; exposed culmen, 11.

109. **Dendroica æstiva sonorana** *Brewst.*—Two specimens: a male and a female, Rio Sestin, April 11 and 14. "Common."

The female is unusually large for this form, the wing (63 mm.) being two millimeters longer than that of any other female in the Museum series of some 30 specimens, mostly from Arizona. Possibly it should be referred to *D. æ. dugesi.*

110. **Dendroica auduboni auduboni** (*Towns.*).—Six specimens, 4 males and 2 females, April 9–14.

Three of the males are of average size; the fourth is unusually large and with the black of under parts very extensive. The wing measures 82.8, tail 62.5. Only one specimen in the large Museum series equals this in length of wing, while only two others closely approach it (wing 82). These three birds are all from El Dorado Co., California. This specimen thus shows an approach to *D. a. nigrifrons* and is possibly an actual intermediate, but the colors of head and upper parts are as in typical *auduboni.*

111. **Helminthophila celata orestera** (*Oberh.*).—Seven specimens, Rio Sestin, April 4–13. These are typical *orestera* in both color and size. Their measurements are as follows: 3 males, wing 63–63.5 (63.2), tail 48.8–50.5 (49.9); 4 females, wing 58.5–62 (60.7).

112. **Helminthophila celata lutescens** *Ridgw.*—One specimen, a male, Rio Sestin, April 9. Of the eight Orange-crowned Warblers in the present series, seven are typical *orestera* as above recorded, but the eighth must be referred to *lutescens*. It is typical of this form in color, but not quite so in size, being a trifle large (wing 61.5, tail 48.5). It is decidedly brighter colored both above and below than any of the 3 males of *orestera* and as it is, at the same time, slightly smaller, it is probably true *lutescens*, and not merely an aberrant example of *orestera*.

113. **Anthus pensilvanicus** (*Latham*).—Two specimens: Villa Ocampo, Feb. 19; Rio Sestin, April 10. "Stragglers only seen."

The April specimen is gaining many new feathers on crown, back, and under parts, and a new pair of central rectrices.

114. **Toxostoma curvirostre curvirostre** (*Swains.*). — Twenty specimens: Rosario, 2 specimens, Jan. 19 and 24; Las Bocas, 5 specimens, Feb. 8 and 11; Boquilla, 1 specimen, Feb. 14; Rancho Santuario, 2 specimens, Feb. 16 and 22; La Cienega de las Vacas, 1 specimen, March 28; Rio Sestin, 5 specimens, April 9–May 4; Rancho

Baillon, 3 specimens, May 6 and 9; Arroyo del Buey, 1 specimen, May 28. "Common steady resident, breeding in May. Native name, Pite cochi."

115. **Mimus polyglottos leucopterus** (*Vig.*).—Eleven specimens: Rio Sestin, 9 specimens, April 9–May 3; Rancho Baillon, 2 specimens, May 6. "Common; migratory; arrives in April; breeds."

116. **Thryomanes bewickii eremophilus** *Oberh.* — Twenty-six specimens: Matalotes, 2 specimens, March 23 and 26; La Cienega de las Vacas, 8 specimens, March 27–April 4; Rio Sestin, 9 specimens, April 9–May 3; Rancho Baillon, 5 specimens, May 10–June 10; Arroyo del Buey, 2 specimens, May 27. "Common steady resident. Breeds." Two specimens (May 10 and 11) are young birds, not fully grown.

117. **Catherpes mexicanus albifrons** (*Giraud*).—Two specimens: Cienega de las Vacas, a female, March 30; Rio Sestin, a male, April 10.

The range of this form of *Catherpes* has not been supposed to extend as far west as northwest Durango but judging by their proportions these specimens appear referable to *albifrons;* whether *polioptilus* is a valid form or not. They are intermediate in size (length of wing) between *conspersus* and typical *mexicanus*, but have the bill as long as in the latter. Their coloration is much nearer that of *conspersus*. Male: wing, 62.2; exp. culmen, 23.7. Female: wing, 58; exp. culmen, 20.

118. **Salpinctes obsoletus notius** *Ridgw.*—Eight specimens: Rancho Baillon, 3 specimens, May 9 and June 10; Rio Sestin, 1 specimen, April 11; Guanacevi, 3 specimens, Oct. 10 and 13; La Cienega, 1 specimen, Nov.

Judging by the very slight differences in proportion between these specimens and a series from the United States, the Durango birds are referable to *S. o. notius*. As there are no young birds in the series, it is uncertain whether the character of young birds from this region would confirm this identification or not. The desirability or recognizing *notius* seems to be very doubtful, the chief or only color characters being in the juvenal plumage, and the adult differing from *obsoletus* only by a very slight and overlapping difference in proportions. The Durango specimens are, if anything, a trifle darker and grayer above than United States birds.

The four spring and summer specimens (2 ♂,2 ♀,), and the four fall birds measure, respectively, as follows: wing, 67.6, tail 50.8, exp. culmen, 18.1; wing 69, tail 54.1, exp. culmen, 17.2.

119. **Heleodytes brunneicapillus obscurus** *Nelson.*—Eight specimens, Rancho Baillon, May 6–13. "Breeding. Found in dry, barren hills of mesquite, about 7000 feet altitude. Rather common."

The measurements of the six adults of this series (omitting the very greatly worn tail of one female), are as follows: 2 males: wing, 81–82.6 (81.8); tail, 76–78.5 (77.3); exp. culmen, 19.7–21.8 (20.8). 4 females: wing, 76.3–78.4 (77.4); tail, 72–75 (73.4); exp. culmen, 19–19.7 (19.4). In color these specimens seem to be typical *obscurus*,—decidedly darker than Arizona and Texas birds.

120. **Certhia familiaris albescens** (*Berlepsch*).—Four specimens: La Cienega de las Vacas, 1 specimen, April 3; Rio Sestin, 1 specimen, April 10; Arroyo del Buey, 2 specimens (one a young bird not full grown), May 22.

121. **Sitta carolinensis mexicana** *Nels. and Palm.*—Seven specimens, all adults: Matalotes, 1 specimen, March 23; La Cienega de las Vacas, 4 specimens, March 28–April 3; Arroyo del Buey, 1 specimen, May 28; San Andres, 1 specimen, Nov. 2.

122. **Auriparus flaviceps flaviceps** (*Sund.*).—Two specimens, Rancho Baillon, May 8 and 9.

123. **Psaltriparus melanotis lloydi** (*Sennett*).—Five specimens, Cienega de las Vacas, March 27–April 5.

As nearly as I am able to judge these are typical *lloydi*.

124. **Penthestes sclateri** (*Kleinschmidt*).—Three specimens: Las Bocas, 1 specimen, Feb. 10; Cienega de las Vacas, 2 specimens, March 31.

125. **Bæolophus wollweberi annexus** (*Cass.*).—Seventeen specimens: Matalotes, 1 specimen, March 26; Cienega de las Vacas, 13 specimens, March 27–April 3; Arroyo del Buey, 2 specimens, May 22 and 27.

These specimens closely agree with United States birds and are appreciably different from Jalisco specimens which are typical *wollweberi*.

126. **Regulus calendula cineraceus** *Grinnell.*—One specimen, a male, Rio Sestin, April 13. "Very common."

This specimen is very pale and gray above. Wing, 60; tail, 46.5.

127. **Polioptila plumbea** (*Baird*).—Four specimens, Rancho Baillon, May 10.

One of these is a young bird, not fully grown. The two adult males appear to be perceptibly paler, both above and below, than United States birds, at least those from Arizona. This species has apparently never before been found breeding as far south as Durango.

128. **Myadestes townsendi** (*Aud.*).—One specimen, Cienega de las Vacas, March 31.

129. **Sialia sialis azurea** (*Baird*).—Five specimens: Las Bocas, 1 specimen, Feb. 9; Matalotes, 1 specimen, March 22; Cienega de las Vacas, 2 specimens, March 30 and April 2; Arroyo del Buey, an adult male, May 27.

The May specimen measures: wing, 104; tail, 71.5.

130. **Sialia mexicana bairdi** *Ridgw.*—Twenty specimens: Arroyo del Buey, 17 specimens, May 22–28; Guanacevi, 3 specimens, Oct. 9. One of the latter, a female, is moulting from juvenal to first winter plumage.

The ten breeding adult males differ little if any in size from Arizona specimens, but possibly average slightly larger. The length of the wing of this series of males, roughly measured, is 106.4–112 (av. 109.7). These specimens exemplify the extreme chestnut-backed type of coloration. The back is broadly and solidly chestnut in every specimen, in one only having a little blue in the median line. The cinnamon of the under parts is also very extensive. These reddish-brown areas are distinctly paler in comparison with Arizona and Colorado specimens.

The Durango females differ from those of Arizona, etc., in having the upper side of head and neck decidedly bluer. This is shown in both the October and the May specimens.

131. **Ridgwayia pinicola** (*Scl.*).—One specimen, an adult female, of this peculiar species, Arroyo del Buey, May 28. "Iris hazel."

Wing, 123.5; tail, 83; exposed culmen, 19.3 (wing and tail both somewhat worn).

132. **Merula migratoria propinqua** *Ridgw.*—Ten specimens: La Boquilla, 1 specimen, Feb. 13; Rio Sestin, 2 specimens, April 10; Arroyo del Buey, 7 specimens, May 24–28.

These do not differ appreciably either in color or size from breeding specimens from the Sierra Nevada in California (El Dorado Co.).

59.54(729.6)

Article XI.—ARACHNIDA FROM THE BAHAMAS.

By Nathan Banks.

Dr. W. M. Wheeler has transmitted to me for determination and report a collection of Arachnida made by him in the Bahamas in the early summer of 1904. Very little has been published on the spider fauna of these islands, indeed the only article of importance is by Mr. F. O. P. Cambridge[1] in which are recorded nine species; only three of which were taken by Dr. Wheeler. The six others are *Lyroscelus bonhotei*, a new genus and species of Theraphosidæ; *Filistata hibernalis* Htz., *Heteropoda venatoria* Linn., *Uloborus geniculatus* Oliv., *U. americanus* Walck., and *Alcimosphenus licinus* Simon. All, except the *Lyroscelus*, are known from various parts of the West Indies.

In this collection are eighteen spiders, and seven other arachnids. Three species are described as new, and two others may be new, but the specimens are not mature. Nearly all of the species have been recorded from the West Indies, Mexico, and the Southern United States. Indeed all of the web-building species occur in the United States, while most of the other forms are confined to more southern regions.

However, too few forms are as yet recorded to make many generalizations; not one attid has yet been taken where one would expect this family to be well represented. The material, and types, form part of the collection of the American Museum of Natural History.

ARANEIDA.

Theraphosidæ.

Acanthopelma maculata sp. nova.

Cephalothorax and legs brownish yellow; eyes on a black spot; mandibles rather more reddish brown; sternum brownish yellow; abdomen gray beneath, spinnerets yellowish, dorsum brown, paler on sides, with three rows of pale yellow spots, median of six and the lateral of five each, a brush of dense, blackish hair at base of the abdomen. Cephalothorax about one third longer than broad, and about once and one half as broad in middle as in front, groove straight, transverse. Head but little elevated; eyes as figured; back of eye region is a median row of five or six erect bristles; mandibles quite large and heavy. Leg short and stout, especially the tarsi and metatarsi of legs I and

---

[1] On a collection of spiders from the Bahama Islands, made by J. L. Bonhote, Esq.; with characters of a new genus and species of Mygalomorphæ. Ann. Mag. Nat. Hist., (7) vol. VII, pp. 322–332, 1 pl., 1901.

II, all thickly clothed with hair, above on patellæ, tibiæ, and metatarsi I and II erect and bristly; no spines on leg I, except one at tip of tibia and one at tip of metatarsus, leg II with only one at tip of tibia, and one on base and one on tip of metatarsus; legs III and IV with three slender spines above at tip of femora, these tibiæ and metatarsi with numerous spines; tarsi scopulate, metatarsi partially so, the tarsal scopula divided by rows of stiff bristles and some spines interspersed, more numerous on the hind pairs; leg IV about as long as body; no trace of a third claw to tarsi. Sternum as long as broad, with erect black bristles; inferior spinnerets as long as hind tarsi, basal joint longest, then second, the third very short.

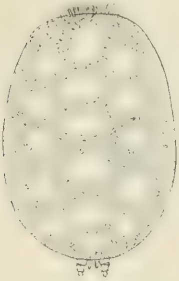


Fig. 1.–*Acanthopelma maculata* sp. nov., abdomen.

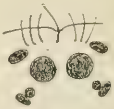


Fig. 2.—*Acanthopelma maculata* sp. nov., eyes.

Length 12 mm.

From Magnolia Key, Andros Island, 25 May. 1

It agrees well with Cambridge's description of the genus, and appears related to the one species, *A. rufescens*, in color, but has three rows of spots on the abdomen instead of the two in that species.

Ischnothele guyanensis *Walck.*—From S. W. Andros Island, 15 May. Widely distributed in the West Indies and northern South America.

Ischnocolus hirsutus *Ausserer.*—Specimens from West Bay, New Providence, 29 May, and Ft. Charlotte, Nassau, N. P., 25 June. Some authors consider that this is the immature state of some other genus. Known from Cuba previously.

SCYTODIDÆ.

Scytodes longipes *Lucas.*—Two specimens from Mangrove Key, Andros Island, 12 June, and 25 May. Quite common in tropical America.

CLUBIONIDÆ.

Anyphæna velox *Becker.*—Immature specimens from West Bay, New Providence, 22 May. Known from Florida, and several of the West Indian Islands.

Wulfila ventralis sp. nova.

Pale yellowish, the tibiæ darker on middle and at tips, and hind metatarsi also darker on middle and tips, elongate dark marks at tips of femora and on base of patellæ, palpi with two narrow dark lines above, on venter there is a transverse black arcuate band over the ventral rima, with the ends acutely prolonged forward, the whole mark somewhat in the form of a W. Posterior eyes large, in a straight row, A. M. E. very small, not one fourth as large as A. S. E. Legs very long and slender; spines very slender, tibiæ I and II with two pairs beneath, metatarsi I and II with one long pair at base, and II with a shorter median pair; tibiæ III and IV with a pair at base and at middle, and one above on base; all patellæ with one at tip above. Abdomen elongate, pointed behind; rima at about one half way from genital fold to spinnerets.

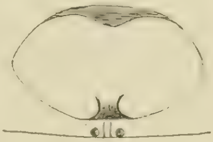


Fig. 3.—*Wulfila ventralis* sp. nov., vulva.

Length 6 mm.

One specimen from Mangrove Key, Andros Island, 25 May.

THERIDIIDÆ.

Theridium rufipes *Linn.*—One female from Ft. Charlotte, near Nassau, New Providence, 25 June. A cosmotropical spider.

Theridium studiosum *Hentz.*—One female from Queen's Staircase, Nassau, New Providence, 31 May. In the Southern United States, south to Brazil.

Lathrodectus mactans *Fabr.*—Several specimens from Mangrove Key, Andros Island, 6 June; and Queen's Staircase, Nassau, New Providence, 31 May. Common in temperate and tropical America.

Dipoena crassiventris *Keys.*—One small female from Ft. Charlotte, near Nassau, New Providence, 25 June. Recorded from Georgia and Florida.

EPEIRIDÆ.

Nephila clavipes *Linn.*—Several immature specimens from Menendez Sisal Plantations, Stanley, New Providence, 26 June. Known from tropical and subtropical America.

Leucauge argyra *Walck.*—One female from Mangrove Key, Andros Island, 25 May. Common in tropical America.

Epeira labyrinthea *Hentz.*—One male from Ft. Charlotte, near Nassau, New Providence, 25 June. Inhabits nearly all North and South America.

Epeira wittfeldæ *McCook.*—An immature female, probably this species, from Dog Key, N. of Andros Island, 13 May. Known from various parts of Florida.

Gasteracantha cancriformis *Linn.*—Two females from Menendez Sisal Plantations, Stanley, New Providence, 26 June. Common in tropical and subtropical America.

CTENIDÆ.

Ctenus sp.

Cephalothorax blackish, a broad pale median stripe, slightly narrowed in front of the groove, and tapering behind; abdomen blackish above, indistinctly marked with pale, an outline of a spear-mark on base; sternum, legs, and venter pale, tibiæ and metatarsi rather darker; mandibles with two black stripes in front, narrowly separated above, indistinct below. Female with tibia I and II with 4—4 spines, male with 5—5 spines; metatarsi I and II with 3—3 spines. A male one moult from adult shows the bulb of the palpus tipped with a long black style curved inward and downward, but it may change position in next moult. Length 9 mm.

Immature specimens from Ft. Charlotte, near Nassau, 25 June, and West Bay, N. P., 29 May. A heavier and darker species than *C. punctulatus.*

Anahita sp.

Cephalothorax blackish in middle, pale on sides, a triangular pale area behind eyes and followed by a narrow pale median stripe, a broad black spot on clypeus surrounding A. M. E. and a vertical mark under each P. S. E., mandibles with a broad black stripe in front. Legs banded; abdomen dark above, pale beneath, with some small black dots. Certainly only two claws to tarsi, and prominent claw-tufts; eyes as figured for *A. fauna* by Simon.

One immature specimen from West Bay, N. P., 29 May.

SPARASSIDÆ.

Selenops aissus *Walck.* — From Mangrove Key, Andros Island, 25 May. Known from southern Florida, and various parts of the West Indies.

SCORPIONIDA.

CENTRURIDÆ.

Centrurus vittatus *Pal. de Beauv.* — From Dog Key, N. of Andros Island, 13 May. Known from various parts of tropical America.

Isometrus maculatus *Linn.* — One specimen from Little Golding Key, Andros Island, 19 June. A cosmotropical species.

SCORPIONIDÆ.

Diplocentrus lesueuri *Gerv.* — From South Side of Bight, Andros Island, 18 May. Described from Cuba, and known also from southern Florida.

PHRYNIDA.

Admetus whitei *Gerv.* — One from High Key, Andros Island, 2 June. Known from several places in Mexico and the West Indies.

Hemiphrynus viridiceps *Poc.* — Several specimens from Mangrove Key, Andros Island, 12 June; from West Bay, New Providence, 29 May; and from South Side of South Bight, Andros Island, 18 May. Recorded from several of the West Indian islands.

PHALANGIDA.

Erginus castaneus sp. nova.

Body above rich brown, a transverse whitish spot above coxæ II, and a narrow whitish band on margin of scutum, just behind the pair of large tubercles; sometimes one or both of these markings lacking. Mandibles dark above on basal joint, elsewhere pale; palpi pale, sometimes faintly mottled on outer side, and dark on underside of the last joint; legs more or less blackish, but the trochanters and bases of femora pale yellowish, also pale on tarsi, on tips of tibiæ, and on bases of metatarsi. Venter reddish brown. Body one and one half times as long as broad, moderately convex in middle, widest in front of coxæ IV, tapering each way, anterior margin one third of greatest width. Anterior part of dorsum with a few granules outwardly behind eyes; beyond coxæ III the dorsum is transversely granulate; a pair of larger, rounded granules in middle of the first band, and a pair of spine-like ones near margin, or in the third band; each segment beyond with a row of granules. Coxæ granulate, more distinct on anterior margin of I, posterior margin of III, and general surface of IV. The ventral segments each with a row of small granules. Femora, patellæ, and tibiæ of the legs are roughened. The male has femur IV with a row of seven to nine compressed teeth above near tip, the highest one not the diameter of the segment; two rows of shorter teeth below and on inner side. Basal segment of mandibles granulate above. Femur of palpus with a row of teeth below on outer edge, tibia strongly flattened and margined on both edges, tarsus with a claw one half its length. Leg IV longest and largest, trochanter, femur, and patella I no longer than femur IV; metatarsi of all legs show false articulations; tarsi I and III with 6 joints, II with 13 joints, IV with 7 joints. Length 4.6 mm.

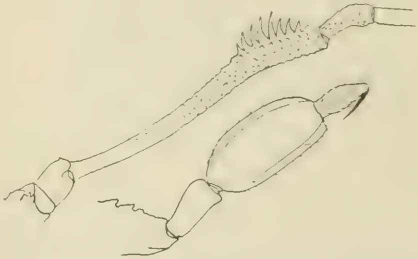


Fig. 4.—*Erginus castaneus*, sp. nov., femur IV, and palpus.

Specimens from Key No. 5, South Side of South Bight, Andros Island, 23 May; Fish Hawk Key, Andros Island, 19 May; and West Bay, New Providence, 29 May. An immature Phalangid of this or an allied species from Ft. Charlotte, Nassau, New Providence, 25 June.

Liobunum sp. — An immature specimen, quite probably of a new species, from Mangrove Key, Andros Island, 25 May.

59.9(72.3)

Article XII. — MAMMALS FROM THE STATES OF SINALOA AND JALISCO, MEXICO, COLLECTED BY J. H. BATTY DURING 1904 AND 1905.

By J. A. Allen.

Plates XX.–XXXIII.

The collections which form the basis of the present paper were made by Mr. J. H. Batty in 1904 and 1905, in continuation of his work in Mexico begun in Durango in 1903. During his three years' work in Mexico as a collector for this Museum Mr. Batty [1] has sent in large collections of mammals and birds, and many reptiles and other natural history specimens, mainly from the States of Durango, Sinaloa, and Jalisco, but including mammals and birds collected in Lower California in October, 1903. Reports upon some of these collections have already appeared in this Bulletin,[2] and others will follow as his work proceeds.

In this connection, I wish to acknowledge my indebtedness to Dr. C. Hart Merriam, Chief of the Biological Survey, U. S. Department of Agriculture, and to the authorities of the U. S. National Museum, for the loan of specimens for use in the present connection; to Mr. Gerrit S. Miller, Jr., Assistant Curator of Mammals, U. S. National Museum, for assistance in identifying various species of Bats; to Mr. A. H. Howell, Assistant, Biological Survey, for similar aid in respect to species of *Reithrodontomys;* and to Mr. Wilfred H.

---

[1] As this paper is passing through the press a telegram has reached the Museum, sent by his assistant, Mr. Sterling Rohlfs, announcing that on May 27, 1906, Mr Batty was instantly killed by the accidental discharge of his gun while collecting for this Museum at Pijijiapam, Chiapas, Mexico. Mr. Batty was a collector of wide experience in tropical America, and was especially successful in securing the larger Carnivores. He was a man of great energy and determination, an enthusiastic collector and hunter, fearless almost to a fault. He was under engagement with this Museum to continue his work across Guatemala, and afterward to visit the Cauca region of southwestern Colombia. His tragic death is thus a serious loss.

Mr. Batty was born at Springfield, Mass., about 60 years ago, but apparently retained his remarkable physical vigor unabated to the end. He fitted for college, but early abandoned his college course for, to him doubtless, more attractive pursuits, and spent his life as a taxidermist and natural history collector. He was the author of a work on taxidermy, and published one or two other books.

[2] 1. List of Mammals collected by Mr. J. H. Batty in New Mexico and Durango, with Descriptions of New Species and Subspecies. By J. A. Allen. This Bulletin, Vol. XIX, 1903, pp. 587–612. Published Nov. 12, 1903.—Donna Ana Co., New Mexico, 7 species, 123 specimens; northwestern Durango, 34 species, 485 specimens. Seven species and 7 subspecies described as new.

2. Further Notes on Mammals from Northwestern Durango. By J. A. Allen. *Ibid.*, Vol. XX, 1904, pp. 205–210. Published May 28, 1904. Sixty specimens, 17 species, adding 6 to the former list (2 new), making a total of 40 species.

3. List of Birds collected in Southern Sinaloa, Mexico, by J. H. Batty, during 1903–1904. By Waldron De Witt Miller. *Ibid.*, Vol. XXI, pp. 339–369. Published Nov. 24, 1905. Number of specimens, 1164, representing 160 species, 1 new subspecies.

4. List of Birds collected in Northwestern Durango, Mexico, by J. H. Batty, during 1903. By Waldron De Witt Miller. *Ibid.*, Vol. XXII, pp. 161–183. Published June 2, 1906. Number of specimens, 829, representing 132 species.

Osgood, Assistant, Biological Survey, for kindly determining the specimens of *Peromyscus*, nearly all of which have passed through his hands in connection with his monographic revision of the group, now nearly ready for the press.

I.—MAMMALS FROM SOUTHERN SINALOA.

The Sinaloa collection was made in the extreme southern part of that State, mostly within a radius of about a dozen miles from Escuinapa (spelled Escuinada on some maps), which point was the collector's headquarters and base of supplies. Most of the specimens are hence labeled simply Escuinapa. His work was thus mainly confined to a narrow coast strip extending from Rosario southward to the Tepic boundary, some fifteen miles south of Escuinapa. This low strip of coast country "is covered with lagoons and rivers. It has a heavy growth of mangroves, and is sparsely interspersed with sandy knolls and flat patches of higher ground covered with other vegetation. East of the lagoons, for the five miles to Escuinapa, and thence to the foothills of the Sierra Madre, is a long flat plain covered mostly with thorny bushes, yuccas, and patches of high grass. On this tract are scattered occasional ranches. Northwest of Escuinapa the country is the same for several hundred miles. The same character of country continues also southeast for seventy miles. . . . East of Escuinapa rise small bushy hills, sparsely covered with chapparal, mesquite, and other thorny bushes and trees. Twenty miles directly east, the altitude is about 3000 feet, at sixty miles 5000–6000 feet, and at the boundary of Durango about 8000 feet. . . . At 4000 feet, oaks first appear; at 5000 or 6000 feet there are grassy hills, the valleys between being wooded, principally with large oaks. Still higher, the oaks are mostly replaced by scattered groves of large pines."[1]

During nearly a year (December 19, 1903, to November 9, 1904) spent in this region, Mr. Batty exhaustively explored the immediate vicinity of Escuinapa, from the coast lagoons and small islands (Hacienda Island and Los Cabras Island) on the coast to the dry plains and knolls to the eastward of the adjoining low coast plain, the altitude ranging from sea level to 100 feet. Excursions were made northward to Rosario (the type locality of a number of small mammals collected by Mr. P. O. Simons in 1897), about twenty miles north of Escuinapa at an altitude of about 500 feet; and to Papachal (altitude 600 feet) and Elota (altitude 800 feet, and about one hundred miles north of Escuinapa). Very few mammals, however, appear to have been taken at either of these points. In the spring of 1904 (March 15 to May 20) an expedition was made to the foothills of the Sierra Madre, nearly to the Durango-Sinaloa boundary, during which 66 mammals were collected, as follows: Lavanilla, altitude 3000 feet, 2 specimens; Los Pieles, altitude 3500 feet, 14 specimens; Arroyo de Limones, 30 specimens; Arroyo de Taquaco, altitude 4000 feet, 1 specimen; Juan Lisiarraga Mountain, altitude 5500 feet, 19 specimens.

---

[1] Compiled by Mr. W. De W. Miller from the collector's notes; see this Bulletin, Vol. XXI, pp. 339, 340

The bulk of the mammal collection from southern Sinaloa is thus from a very circumscribed locality, and probably includes about all the species found there, with the probable exception of a number of species of Bats. It is thus of special interest as thoroughly representing the mammal fauna of a definite area, which thus becomes available for comparison with other well-worked localities, as the limited district in northwestern Durango explored by Batty in 1903, and the nearer localities in northwestern Jalisco carefully worked by him in 1905. A comparison of results shows that of the 40 species (or 37, excluding the introduced species of *Mus*) obtained in northwestern Durango only one, the Gray Fox (*Urocyon cinereoargenteus scottii*), is found in either southern Sinaloa or northwestern Jalisco, and possibly a *Nyctinomus*. It is also shown that of the 41 species and subspecies (39, excluding *Mus*) found in southern Sinaloa only 16 are included in the 60 species and subspecies taken in Jalisco, although 3 others have representative subspecies in the two regions, notwithstanding that the Sinaloa and northern Jalisco localities are separated geographically by a distance of rather less than 200 miles.

The Sinaloa collection is perhaps most remarkable in what it lacks, since it contains no Spermophiles, no species of Wood Rat (genus *Neotoma*), only one species of Skunk (genus *Conepatus*, *Mephitis* and *Spilogale* being both absent), and no species of the family Geomyidæ. None of these could well have been overlooked had they been present. Species of *Neotoma* and *Thomomys* are, however, well known to occur not far to the northward of Escuinapa.

Mr. Batty evidently gave special attention to the larger mammals, these being represented in large series, and are especially welcome as giving unusual opportunity for the study of individual, seasonal, and age variations in a number of species. There are, for example, about 100 specimens of *Nasua*, nearly 50 of *Procyon*, 15 of *Conepatus*, 44 of *Didelphis*, 20 of *Tatu*, 23 of *Tayassu*, over 100 of *Odocoileus*, 14 of *Lynx*, 24 Ocelots, 5 Jaguars, and corresponding series of the common Rodents and Bats. The collection numbers altogether 825 specimens, representing 41 species.

As in his previous collections, Mr. Batty has usually taken four measurements of most of the specimens, namely: (1) Head and body; (2) tail vertebræ; (3) hind foot (measured to the end of the longest toe, and hence not including the claws); (4) ear, measured from the notch, and in some cases also from the crown. The total length, as given in the following pages, is made up (for convenience in comparison with the usual 'total length') by adding the collector's first two measurements. He was obliged to take his measurements in inches and fractions (usually 16ths), owing to the early loss in the field of his metric rule, so that it has been necessary to reduce them to the metric system. In the case of the larger species, such additional measurements were taken as would be required by the taxidermist in mounting the specimen, but they are here omitted as being not especially useful.

In the following measurements of skulls, total length is the greatest length of the skull (=condylo-basal length of Thomas); basal length is the distance from the inferior border of the foramen magnum to the inner base of the middle incisor (=basilar length of Hensel and Thomas); occipito-nasal length, used only for the species of *Lepus*, is to be taken in its literal sense[1] — occipital crest to front border of nasals; palatal length, from inner base of incisors to palatal notch (=palatilar length of Thomas). Other measurements, when requiring explanation, are explained as used.

The measurements are, of course, always in millimeters, unless otherwise stated.

1. **Marmosa sinaloæ** *Allen*.

Nine specimens, Escuinapa, Jan. 8 and 28, Feb. 5 and 6, June 24, July 3, 4, 15, and 17.

---

[1] Occipito-nasal length has been used for "the greatest length of the skull," or for the "length on median line from occipital crest to front of nasals," by the same authors on different occasions. "Basal length" and "basilar length" have been defined by one and the same author, in different connections, to mean: Basilar length, (1) occipital condyle to incisor, or more explicitly, from one of the occipital condyles to the posterior edge of the alveolus of the middle incisor of the same side; (2) from condyle to front border of premaxilla. Basal length, from basion (anterior margin of foramen magnum) to gnathion (front edge of premaxilla); greatest basal length, condyle to front of premaxilla. In cases (which are many) where these terms are used without definition, there is always uncertainty of meaning. I find I have myself, in common with many other writers, used the same terms in slightly different senses in papers published at different times. Mr. Oldfield Thomas's recent 'Suggestions for the Nomenclature of the Cranial Length Measurements and of the Cheek-teeth of Mammals' (Proc. Biol. Soc. Washington, Vol. XVIII, pp. 191–196, Sept. 2, 1905), are therefore especially welcome, and should lead speedily to the use of a definite and uniform system of terms among all mammalogists. That Thomas's terms are not adopted in this paper is due to the fact that most of the measurements had been taken and a large part of the manuscript prepared before his excellent paper appeared.

Measurements: An adult female, total length, 247; head and body, 114; tail, 133; hind foot, 18; ear from notch, 22 mm. Two adult males average, total length, 269; head and body, 127; tail, 142; hind foot, 19.8; ear, 23.

2. **Didelphis mesamericana mesamericana** (*Oken*).

Thirty-six skins and skulls, and 8 additional skulls, all from Escuinapa, Jan. 1–Feb. 2 (adults), June 26, July 5 (2 nurslings). The series includes 15 adult males, 11 adult females, 3 young adults, and 7 young apparently only a few weeks old (length of head and body, 140–160 mm.). Of the adults 16 represent the black phase, and 12 the gray phase, divided about equally as to sex, while the 8 young ones are all of the black type. The series, excluding the nurslings, consists almost wholly of middle-aged adults, with a few very old specimens and a few in which the dentition is not quite mature.

The measurements of this series, both external and cranial, fall considerably below those of specimens from central and eastern Mexico (*D. mesamericana tabasensis*), but agree in this respect with specimens from Jalisco and Colima.

Twelve adult males give the following: Total length, 805 (767–845); head and body, 418 (394–445); tail vertebræ, 387 (373–406); hind foot without claws, 56.5 (54–60); ear from notch, 51.3 (45–54). Skulls of same: Total length, 112 (106–119); zygomatic breadth, 53.5 (49–55).

Nine females: Total length, 747 (711–788); head and body, 376 (356–394); tail vertebræ, 341 (328–390); hind foot, 52 (48–56); ear, 50 (48–52). Skulls: total length, 100.6 (93–110); zygomatic breadth, 47 (42–52).

A similar series of specimens from the State of Jalisco give practically the same measurements, the average total length of the skull being exactly the same, and the external measurements average practically the same, while a similar number of specimens from the States of Vera Cruz, Tabasco, and Chiapas are much larger, as follows: Total length (11 males), 887; head and body 468; tail vertebræ, 415; total length of skull, 121; zygomatic breadth, 61.5: 9 females, total length, 798; head and body, 412; tail vertebræ, 387; total length of skull, 104; zygomatic breadth, 51. The difference in total length is 82 mm. in the males and 51 in the females, and in total length of skull in the males, 9 mm., and in zygomatic breadth, 8 mm., with corresponding differences in the females.

3. **Tatu novemcinctum mexicanum** (*Peters*).

Twenty specimens, all from the immediate vicinity of Escuinapa, Dec. 28–Jan. 7, and one each Feb. 9 and March 5. Only 4 have fully acquired the permanent dentition, and only one has merely the milk dentition; in all the others the milk dentition is being replaced by the permanent teeth, every stage of the change being represented in different specimens.

As is well known, the change occurs relatively late in life, nearly all the specimens in the present series which show the change having nearly or quite attained adult size. The sexes are about equally represented.

The females are considerably smaller than the males, as shown by the following measurements:

Eight males: Total length, 825 (744–903); head and body, 431 (386–483); tail, 381 (356–419); hind foot (with claws, from skin), 83 (80–85); ear, 37 (32–40).

Seven females: Total length, 728 (679–762); head and body, 367 (330–419); tail, 361 (330–394); hind foot (from dry skin), 82 (75–86); ear, 35.4 (32–38).

Unfortunately the front border of the nasals is defective in most of the skulls, but in 4 complete male skulls the total length of the skull ranges from 91–101.5, averaging 97.4; two female skulls have a total length, respectively, of 85 and 89. Zygomatic breadth, 8 males, 38.5 (36–42); 6 females, 37.5 (35–40). Mastoid breadth, 8 males, 27.5 (26–28.5); 6 females, 26.5 (25.5–27).

The number of teeth varies from $\frac{7-7}{7-8}$ to $\frac{8-8}{9-8}$, as follows: 5 skulls, $\frac{7-7}{8-8}$; 11 skulls, $\frac{8-8}{8-8}$; 2 skulls, $\frac{8-7}{8-8}$; 1 skull, $\frac{7-7}{7-8}$; 1 skull, $\frac{8-8}{9-8}$. The skull varies greatly in different specimens independently of sex or age, particularly in the relative length and breadth of the rostrum, and in other individual elements, as notably the lachrymal bone. The nasals vary in width (at the narrowest part) from 4.5 to 7 mm., and also vary in relative length. The lachrymal varies greatly in size, and also in form, from triangular to quadrate. Generally it is triangular, with the apex forming a sharp angle at the antero-superior border, the upper border being straight and horizontal, and the anterior border a straight obliquely descending line; the lower border and also the posterior border are sometimes approximately straight, although the former more commonly rounds upward to meet the front border without forming a distinct angle. The lachrymal is thus usually three-sided, with the upper and posterior margins straight

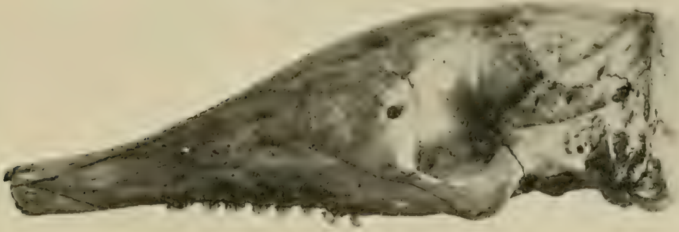


Fig. 1. *Tatu novemcinctum mexicanum.* No. 24054, ♀, Escuinapa, Sinaloa, Jan. 7, 1904, J. H. Batty. Nat. size. (Tip of nose broken off.)

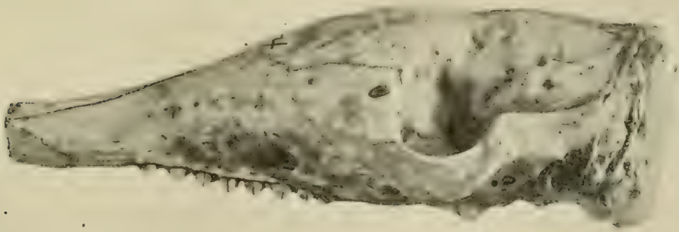


Fig. 2. *Tatu novemcinctum mexicanum.* No. 24063, Escuinapa, Sinaloa, J. H. Batty. Nat. size. (Tip of nose broken off.)

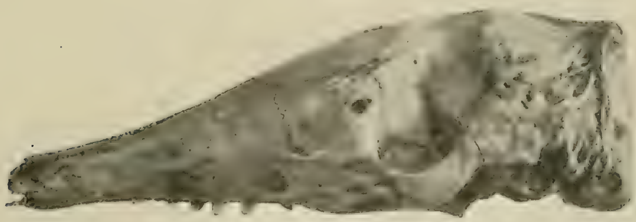


Fig. 3. *Tatu novemcinctum mexicanum.* No. 24732, ♂ Escuinapa, Sinaloa, March 5, 1904, J. H. Batty. Nat. size. (Tip of nose broken off.)

and the antero-inferior convex. More rarely it is practically quadrate, or the anterior portion may be rounded on the upper as well as on the lower margin. It varies not less in proportions than in form: in perhaps the larger number of cases the antero-posterior and vertical diameters are nearly or exactly equal; in other cases the vertical greatly exceeds the antero-posterior, and in other cases it may be less. Six skulls selected to show variation in this respect have the antero-posterior length and the vertical length of the lachrymal as follows: 14.5 × 11, 14 × 14, 15 × 13, 13.5 × 11, 15 × 14, 14 × 12 mm. Figures 1–3 illustrate examples of purely individual variation.

The number of free dorsal bands in the carapace, along the median line, is 8 in 18 specimens out of 19, the other having 9, or 9 and 10 bands respectively in all. Four Texas specimens also have 8, while one from Trinidad, B. W. I., 4 from Santa Marta, Colombia, and 3 from Chiriqui, Panama, have each 9 free bands, or 10 in all.

In regard to the relationship of the nine-banded armadillos of Texas and Mexico to those of Central America and South America, little can here be said, owing to lack of proper material. These animals are subject everywhere to such a wide range of individual variation that large series of specimens are necessary from many localities in Central and South America for comparison with those now in hand from Mexico before satisfactory conclusions can be reached. It appears evident, however, that the Mexican form is subspecifically separable from those occurring in Central America and southward, but I fail to see any appreciable differences that are of any importance between specimens from Texas[1] and western Mexico.

4. **Tayassu angulatum sonoriense** (*Mearns*).

(Plate XX.)

Twenty-four specimens, of which 14 are fully adult, and the others more or less immature; both sexes are about equally represented. They were all collected at or in the immediate vicinity of Escuinapa, as follows: Dec. 24–26, Jan. 3–10, 19, Feb. 17–23, March 4, April 19 22, May 3, 23.

As shown below, this series of specimens presents a wide range of individual variation, both in coloration and cranial characters, but the animal from southern Sinaloa seems better referable to *sonoriense* than to either of the other described forms of the *T. angulatum* group. None of the several recognized forms of this group seems to be at all sharply differentiated, the average differences being more or less obscured by the large amount of individual variation found in every large series of specimens. True *T. angulatum*, from the Lower Rio Grande and eastern Texas, is darker, with a more massive skull, broader postpalatal region, and rather heavier dentition than *sonoriense*, as represented by Arizona specimens, which are, on the other hand, rather lighter and grayer than the Escuinapa series, with also a relatively broader skull. The Arizona specimens are, however, much older than any of the specimens from Escuinapa, and the slightly more massive character of the skull may be due to the greater age of the specimens.

---

[1] Recently separated by Mr. Vernon Bailey as *Tatu novemcinctum texanum*. (N. Amer. Fauna No. 25, p. 52, figs. 5 and 6. Oct. 1905.)

"Most common along the Pacific coast, especially in the lowlands. They follow up cañons and beds of streams, in small bands or singly, often to an altitude of 5,500 feet but few are found higher than 2,000 feet. Those found at the higher elevations are larger and shyer, and have longer and coarser bristles. I have never seen any more than ninety miles (air line) from the Pacific coast.

"The Peccary interbreeds freely with domestic pigs, and associates with them on apparently as good terms as with its own kind. It feeds on many things, like the bear, but principally on the leaves of various shrubs, the blossoms of flowering trees, wild figs, berries, and the fruit of the coporno.

"During many years' observations, I have never seen a female with more than two young, though it is said by the natives about Escuinapa that as many as seven young have been found, on several occasions, with one female.

"The hearing of the Peccary is acute, and it has a keen sense of smell. Both sexes are hard fighters. An old male generally leads the band, and at a signal from him the others will scatter and hide, or attack, as the case may be. Many dogs are killed by Peccaries, being torn open or gashed by their long, sharp-edged canine teeth. When about to attack, the Peccary lowers its head, champs its teeth, and advances sideways with its mouth open and under jaw turned to one side, ready for an upward lunge to rip up its enemy. When a band is attacked by many dogs, the Peccaries immediately close up in a bunch, forming a ring with heads outward, which position they stubbornly maintain, fighting until the dogs leave them, the dogs knowing that they cannot break the circle without being killed or badly cut by the Peccaries' tusks." — J. H. B.

The collector's measurements are as follows: 9 adult males (m^1 slightly worn in the youngest, and the teeth not greatly worn in any), total length, 895 (812–970); tail, 30 (25–37); hind foot — measurements not available; ear, 93 (89–110): 5 adult females (teeth only slightly worn, the wear except in one specimen limited to m^1), total length, 913 (889–939). The females average slightly larger than the males, in both external and cranial measurements, as shown by the subjoined table of measurements of the skulls.

There is much variation in respect to coloration. Taking the series as a whole, two color phases are fairly recognizable, a yellowish phase and a gray phase, the latter predominating in the ratio of about 6 gray specimens to 1 yellow. In the yellow phase the yellowish tint is most pronounced on the 'collar,' or oblique shoulder stripes, and on the sides of the head and neck. In several specimens these parts, but especially the 'collar,' are strong yellowish buff, as in *T. a. humerale*, and the sides of the body are also strongly suffused with buff. In the gray phase, in extreme specimens, the collar is white, as is the ground color of the sides, but generally there is a more or less decided suffusion of pale buff. The shoulder stripes are a pronounced feature in only about half the specimens; in some they are entirely obsolete; in a few they are strongly developed, but in most of the specimens they are not conspicuously prominent. The amount of black in the dorsal area is also variable, depending upon the amount of black tipping the bristles.

There are several noteworthy cases of individual variation in cranial characters, especially in the length of the upper molariform series, the breadth of the skull as compared to its length, breadth of the posterior nares, relative size of the bullæ, etc. In one adult male skull with a basal length of 192 mm. the zygomatic breadth is 104 mm.; in another adult male skull of exactly corresponding age, but having a basal length of only 183 mm., the zygomatic breadth is 120 mm. This skull is not exceptionally broad in other measurements, and only in this respect forms a striking variant from the rest of the series. A female skull, the largest and slightly the oldest of the series of females, also departs widely from the normal in the great length of the palatal region and of the upper molariform series, which each have a length of 6 mm. above the average, combined with a zygomatic breadth 2 mm. below the average. There is great individual variation in both the form and size of the audital bullæ, the breadth sometimes nearly equalling the length (24 × 26 mm.) or being much less (20 × 25 mm. or 18 × 22 mm. etc.).

The length of the upper molariform series (pm^1 – m^3) varies in the males from 61 to 67 mm., and in the females from 54 to 69 mm.! In the females the range, with one exception, is from 61.5 to 69 mm., with various intermediate stages in both series, as shown in the subjoined table of measurements.

There is, further, a striking variation in the structure of the middle region of the ventral aspect of the skull. This consists in the presence or absence of an elongated bulbous expansion outside of the walls of the narial passage. This expansion is due apparently to the development of a large sinus between the two plates of the orbitosphenoid. It is convex externally, with a transverse diameter of 10 to 15 mm., a vertical diameter of 15 to 20 mm., and a length of 35 to 40 mm., or more, it extending posteriorly to or slightly beyond the plane of the palatal notch, and anteriorly about to a plane passing between m^1 and m^2. Its external wall is thin, papery, and generally very fragile; the enclosed cavity may be entirely hollow or more or less filled with inosculating bony lamellæ. This bulbous expansion of the orbitosphenoid is present in rather more than half of the Escuinapa series of skulls (in 12 out of 21), and also in about the same proportion in the Peccary skulls from other Mexican and United States localities; it is developed symmetrically in both orbitosphenoids, but varies more or less in size, according to the extent to which it may be developed in different specimens. It is also present in both sexes, and in young specimens which still retain the entire milk dentition as well as in adults.

Associated with this striking modification of the orbitosphenoids is an abnormal inflation of the maxillary arm of the zygoma and of the lower part of the lachrymal which become often enormously expanded, with thick walls enclosing a sinus, contributing still further to greatly modify this portion of the skull. (See Plate XX, and accompanying descriptive matter.) It is evident that this strange modification of the orbitosphenoids and adjacent parts is pathological in character, due probably to the presence of parasites, that can readily find their way from the sinuses of the posterior nares into the maxilla and adjoining parts of the skull.

In this connection an examination has been made of nearly 50 skulls of Peccaries in the Museum collection from various parts of South America, with the following results: In a series of 17 skulls of *T. pecari* from the Santa Marta district of Colombia, all were found diseased in the manner above described, so that this condition might readily be mistaken for the normal. In 20 skulls of T. *torvum* about 80 per cent. show the diseased condition strongly, and others show traces. Of 9 skulls of *T. tajacu* from Chapada, Matto Grosso, Brazil, MEASUREMENTS OF 13 SKULLS OF *Tayassu angulatum sonoriense.*

Mus. No.	Sex	Total length.	Basal length.	Palatal length.	Breadth of rostrum.	Zygomatic breadth.	Breadth at postorbital processes.	Breadth of braincase.	Breadth of palate at m^2.	Breadth of basioccipital.	Length of upper molariform series.	M^3, length × breadth.	Condition of teeth.
24593	♂	228	181	134	28.5	106	70	52	21	16.5	63	13×11	M^1 slightly worn.
24587	♂	246	192	135	32.5	104	80	58	21	17	67	14.5×13	Only m^1 worn.
24584	♂	231	176	129	29	106	75	57	20	17	62.3	13×12	M^1 much worn and other teeth slightly worn.
23865	♂	223	175	124	29	99	70	51	15.5	15	66	13×14	All more or less worn.
23873	♂	223	172	123	28.5	93	69	58	19	15	61	13×10.5	M^1 slightly worn.
23866	♂	219	172	125	28	91	66	54	20	17	61.5	13×11	M^1 slightly worn.
23867	♂	234	184	135	29.5	—	70	53	19	16	66	13×12	M^1 slightly worn.
23864	♂	239	183	135	31	120	78	57	20.5	—	66	13×11	M^1 much worn.
Average	8 ♂ ♂	238	179	130	29.5	101.5	72.3	55	19.5	16.2	64.1	13.2×11.8	
23876	♀	235	183	134	30.5	105	76	57	20	16	66	13×11.5	M^1 much worn.
24585	♀	234	183	132	31	100	68	52	19	16	54	13×11	M^1 slightly worn.
24586	♀	241	186	136	33	105	70	53.5	20.5	17	64	13×11	M^1 slightly worn.
24588	♀	234	182	129	30	97	69.3	54	20	17	61.5	13×11	M^1 slightly worn.
23874	♀	247	190	140	30	99	73	56	20	16	69	15×12	M^1 and m^2 much worn.
Average	5 ♀ ♀	238	185	134	30.9	101	73.3	54.5	19.9	16.5	62.9	13.5×11.3	

Note to Table of Measurements.—Total length = front border of premaxillaries to posterior border of occipital crest; basal length = inner base of incisors (not from between the incisors) to anterior border of foramen magnum; palatal length = inner base of incisors to palatal notch; breadth of rostrum = greatest width of rostrum in front of canines; breadth of basioccipital = between carotid foramina; last molar = length of crown surface on median line, and greatest width of front half.

2 only are normal. The inflation of the bones forming the antero-inferior wall of the orbit, through the invasion of these parts by some parasite, is so general in the whole group of Peccaries that the absence of such conditions seems to be almost exceptional.

An enlargement of the frontal region in the skull of certain species of the Mustelidæ, especially in the Skunks, due also to a parasite, is well known, but it is apparently less general than is this still more striking pathological modification of the skull in the Peccaries, which may also be well known, but to which I have thus far seen no reference.

Three skulls from different localities in the State of Jalisco (see below, under next article) average the same as the Escuinapa series, and each can be exactly matched by skulls in that series. Four skulls from Arizona, each much older than any in the Escuinapa series, have the same average length but are much broader in nearly all of the transverse measurements, due apparently to their greater age. Old skulls from eastern Texas are slightly larger in all measurements than even the old Arizona skulls, with decidedly heavier dentition and greater postpalatal and basioccipital breadth.

5. **Odocoileus sinaloæ** *Allen.*

(Plates XXI–XXVI.)

One hundred and seven specimens, topotypes of the species, of which about 70 are carefully prepared skins, mostly with good skulls, and 35 are hunters' skins,[1] more or less imperfect. They represent adults of both sexes, and young from six to eight months old and upward to young adults. They were collected as follows: In January, 22 specimens; in February, 39 specimens; in March, 15 specimens; in May, 8 specimens (3 are skulls without skins); in December, 2 specimens. The remainder are mostly hunters' pelts, generally without date of collecting; the greater part of them are winter specimens, but several are in summer pelage.

"Ranges from the coast eastward to the second range of the Sierra Madre. Most numerous in the wet season (July to November, inclusive) in the mountains, returning in large numbers to the lowlands and foothills of the coast region during the dry season. The females have one and sometimes two fawns in June and July. This species is a jumper, clearing high fences when in search of squashes or bean vines, which they greedily devour." — J. H. B.

---

[1] The large series, especially of hunters' skins, is due to the fact that many deer were killed to supply the camp, and also the natives of the vicinity, with meat, and the collector utilized the pelts as specimens.

As many of the deer which were saved for mounting were killed and brought in in a mutilated condition by native hunters, only about one-third of the specimens were measured before skinning, and of these many are immature. Only six of the measured bucks appear to have been fully adult, and of these only two or three were 'old adults.' Of the measured does eight are adult, while several of them are quite old. The collector's available external measurements are as follows:

Males, 6 adults: Total length, 1440 (1384–1461); head and body, 1217 (1168–1245); tail vertebræ, 223 (191–254); ear from notch, 141 (130–146).

Females, 8 adults: Total length, 1277 (1182–1340); head and body, 1123 (1092–1156); tail vertebræ, 191 (178–197); ear, 140 (127–146).

The pelage of the Sinaloa Deer is fine and short, and thus very unlike that of northern deer. While there are only a few summer specimens, the large series of winter specimens gives abundant opportunity for the study of individual variation in coloration. The species was originally based on two immature December specimens, which prove to represent the average winter coloration, but a fuller description, based on the present ample material, is now presented. Also many illustrations of skulls are given, to illustrate not only the cranial characters, but their wide range of variation.

In January specimens the pelage of the upper surface has a length of only about 12 to 15 mm.; the individual hairs are smoke-gray, lighter at the extreme base, with pale buffy gray tips. The general coloration is, in general effect, in average specimens, pale buffy gray, darker on the middle of the back, shoulders, and dorsal aspect of the neck, and quite blackish on the forehead and crown; the flanks are lighter and more buffy, shading into a rather ill-defined lateral line of yellowish drab; sides of face, sides of neck, and ears externally dingy gray brown; there is the usual whitish noseband, divided mesially and bordered by dark brown; the upper surface of the tail is strong fulvous, sometimes mixed with dusky, the sides and lower surface white; the throat, from the chin posteriorly, is dull white or grayish white, with the usual chin-bar of black, broken in the middle by white; on the foreneck the white of the throat passes into pale brownish gray, which shades into darker drab-brown on the chest; axillar regions fulvous; inside of fore legs white; belly white, as is the inside of the hind legs, the white extending down the inside of the legs in a narrowing band, nearly to the "knees"; legs externally buffy gray, with a narrow whitish or pale buff line bordering the hoofs.

From this medium phase the general coloration varies on the one hand, through the suppression of the fulvous suffusion, to a pale light gray above, darkening along the median line, and without fulvous at the lower edge of the flanks, very little in the axillæ, and with pale gray instead of fulvous legs; on the other hand, through the great increase of the fulvous suffusion, to a decided fulvous cast above, with the lower edge of the flanks, axillæ, chest, and legs strong fulvous, and the upper surface of the tail bright chestnut to dark chestnut.

The summer pelage above is strongly fulvous throughout, darkest along the vertebral line, especially anteriorly, passing into deep buff, or ochraceous buff, on the flanks and legs. In the half-dozen summer skins the fulvous tint varies in different specimens from clear yellowish buff to deep ochraceous buff, the coloration of the summer pelage thus being in strong contrast with the much darker and grayer tone of average winter examples.

The antlers in individuals of the same age vary widely, as usual in deer, in form and size. Compared with those of northern forms of the *O. virginianus* group, they are of course always small. But in males of 4 years old and older, it is not always the oldest that have the largest antlers. In males of 6 to 10 months old, with m^1 just fully functional, the antlers are merely a bony process covered with skin and hair; in males 18 to 20 months old, with $m^1 - m^3$ in place and the milk premolars not yet shed, the antlers appear as spikes about 60 to 125 mm. long, sometimes slightly forked at the tip; in males about 30 to 34 months old $p^1 - m^3$ are fully developed, and the antlers may be 130 to 180 mm. long, one or both usually with a single basal tine, but sometimes forming merely a slender spike; males 4 to 5 years old begin to show wear on m^1 and sometimes on other teeth, and carry 3-tined or 4-tined antlers, or one may be 3-tined and the other 4-tined, — in other words, the antler may be forked either two or three times.

In adults the antlers at base are directed backward, outward, and more or less upward, according to the individual, and then curve sharply inward at the second fork, or a little beyond the middle of the main beam. The length of the main beam, measured along the outside convexity, varies in males of practically the same age from 240 to 340 mm., and in greatest breadth from outside to outside from 225 to 310 mm., resulting in antlers of widely different appearance.

It is of interest to note that in a series of 25 male skulls one only has a pair of well-developed upper canines, but another has a perfect canine alveolus on one side, the tooth having fallen out; in the other 23 skulls there is not a trace or suggestion of even an alveolus at this point. Still more exceptional is a single female skull, out of a series of 25, with a pair of well-developed canines.

Another erratic modification in the dentition is the reduction of the posterior column on m^3 to a rudimentary condition, while in another specimen m^3 on the left side has a well-developed supernumerary column at the posterior border of the tooth, making four columns instead of three, the corresponding tooth on the opposite side being normal. Furthermore, the molars may have a well-developed accessory column (5 mm. on m^3) or have no trace whatever of such a feature.

The following table of measurements gives the principal dimensions of 6 adult male skulls and 6 skulls of adult females, and serves to show the large amount of purely individual variation that may be expected in any large series of deer skulls. Besides the considerable range in size, the variation in certain parts is striking, especially in the form and relative size of the nasal bones, in the length of the toothrow, and in the upward extension of the premaxilla toward the nasals. There is generally a vacuity between the upper border of the premaxilla and the antero-lateral border of the nasal of the same side of from 5 to 10 mm. in extent, but in a few specimens these parts are in actual contact for a space of 2 to 15 mm. Every stage of gradation, in different specimens, from extended contact (see Pll. xxi–xxvi[1]) to wide separation, is present. The differences in the form and relative size of the nasals (see same Plates), and the variation in the relation of the premaxilla and maxilla to the nasals, would be of great importance wherever occurring with constancy, but in the present series of deer (and also in other species of deer), they are so inconstant, with every stage of intergradation between the extreme conditions present, that they are obviously to be regarded as due merely to individual differentiation. With only the extreme phases of these differentiations present, as might happen in the case of a small series of specimens, and especially if the specimens came from different localities, or

---

[1] Plates xxi–xxvi, *Odocoileus sinaloæ*,—10 skulls, dorsal and lateral views of each, $\frac{1}{2}$ natural size, as follows: 2 adult males, 4 adult females (in 4th year), and 4 young males (all in 3d year), to show individual variation in the size and shape of the nasals, in the size and shape of the lachrymal fossa, and in the relation of the nasals to the maxilla and premaxilla. See also Plate xxxi for further illustration of these variations in 8 young male skulls.

Measurements of 12 Skulls of *Odocoileus sinaloæ* from Escuinapa, Sinaloa, Mexico.

	25554 ♂	24808 ♂	24528 ♂	23884 ♂	24850 ♂	24809 ♂	Av'ge. 6 ♂♂	23878 ♀	23890 ♀	24550 ♀	23915 ♀	23916 ♀	24555 ♀	Av'ge. 6 ♀♀
Condylo-basal length	236	230	216	227	245	—	231	217	217	229	212	218	221	219
Palatal length	156	151	141	145	157	141	148	140	142	149	142	132	137	140
Interorbital breadth	52	56	59	55	61	60	57	57	59	52	51.5	52.5	51	54
Postorbital breadth	82	80	83	78	82	—	81	65	62	60	61.5	55	57	60
Breadth at lower edge of orbits	105	102	106	101	106	—	104	98	96.5	96	91	92	89	94
Palatal breadth at m³	41	41	40	38	42	40	40	40	39	39	40	37	35	38
Distance between premaxilla and nasal	6	2	5	10	0	0	5.8	5	6.5	4	4	0	8	4.6
Nasals, length	75	77	63	68	81	72	73	75	71.5	76	69	66	74	60
Nasals, breadth anteriorly	22	20	18	22	22	19	20.5	16	17	16	16	18	15.5	16.4
Nasals, breadth posteriorly	21	21	21	19	24	25	22	25	20	19	21	21	20	21
Length of upper toothrow	70	72	65	69	61	66.5	67.1	66	72	72.5	65	63	63	67
Length of lower toothrow	73	74	63	73	70	72	71	79	79	71	71	67	68	71.5
Antlers, along external curvature	340	255	240	200	——	250								
Number of points	4-4	3-4	3-3	4-4	——	3-4								
Condition of teeth	m. w.	s. w.	m. w.	m. w.	m. w.	s. w.		m. w.	s. w.	s. w.	m. w.	m. w.	m. w.	

Note to Table of Measurements.—Condylo-basal length (of Thomas) = posterior border of occipital condyles to front border of premaxillæ; palatal length = posterior palatal notch to front border of premaxillæ; length of upper toothrow = at crown surface; length of lower toothrow = at alveolar border. Condition of teeth: m. w. = much worn; s. w. = slightly worn.

occurred in a fossil state, they might prove extremely misleading and be easily mistaken for characters of specific importance, or even of generic value in the case of the premaxilla-maxilla-nasal modifications. I have on various occasions called attention to the wide range of individual variation shown in cranial and other characters in a large number of species of mammals, but generally without giving graphic illustrations of them, and therefore take the present occasion to illustrate by photography a few of the individually divergent specimens in the present series of Escuinapa deer.

6. **Sciurus sinaloensis** *Nelson.*

Nineteen specimens: Escuinapa and vicinity, 10 specimens, Jan. 11, Feb. 18–27, March 1, 18; Los Pieles, 6 specimens, April 4–19; Juan Lisiarraga Mountain. (alt. 5500 ft.), 3 specimens, April 29–30, May 5.

"Found in the lowlands and foothills west of the Sierra Madre. Not very common."—J. H. B.

Escuinapa, 8 males: Total length, 514 (502–537); head and body, 249 (235–254); tail vertebræ, 265 (254–283); hind foot without claws, 59 (57–60); ear from notch, 31 (29–32).

Los Pieles (alt. 3500 feet) and Juan Lisiarraga Mountain (alt. 5500 feet), 8 specimens, nearly all males: total length, 513 (502–540); head and body, 249 (235–254); tail vertebræ, 264 (254–286); hind foot, 59 (54–63); ear, 29 (25–32).

The range of this species is thus shown to extend from the low arid coast region of southern Sinaloa eastward into the eastern foothills of the Sierra Madre, to altitudes of 3500 and 5500 feet. The specimens from the Sierra Madre foothills do not differ appreciably in size (see above measurements) or color from those of the coast region.

7. **Mus alexandrinus** *Geoffroy.*

Six specimens, Escuinapa, Dec. 27, Jan. 1, 8, and Feb. 3, 5, 18. "Found common in mangroves."—J. H. B.

8. **Mus musculus** *Linn.*

Six specimens, Escuinapa, Jan. 23, Feb. 3 and 19.

9. **Peromyscus spicilegus spicilegus** (*Allen*).

Twenty-three specimens, Escuinapa, Jan. 13, April 24–May 5. Five of the 6 January specimens and one April specimen are in the gray first pelage; nearly all of the others are adult. Three of the specimens are in formalin, the others being skins with skulls.

10. **Peromyscus (Baiomys) musculus musculus** (*Merriam*).

Nine specimens, Escuinapa, Jan. 5–8, May 27, and July 7 (the latter four specimens in formalin). Not appreciably different from Tepic and Jalisco specimens.

11. **Sigmodon hispidus colimæ** *Allen*.

Sigmodon hispidus mascotensis BAILEY, Proc. Biol. Soc. Wash. XV, p. 108, June 2, 1902; not *Sigmodon mascotensis* Allen, 1897.

Seventy specimens, vicinity of Escuinapa: Dec. 25–Feb. 18, 63 specimens; May 26, 27, 2 specimens; July 4–8, 5 specimens.

About two-thirds of the specimens are old adults, 5 are very young (only a few days old), a few are one-third to two-thirds grown, and the remainder are young adults. The males preponderate, there being 42 males to 26 females. Of the 5 young in first pelage, 4 were taken Jan. 8 and 1 Feb. 6.

The 10 *largest* adult males measure as follows: Total length, 299 (267–365); head and body, 156.4 (140–178; tail vertebræ, 136.7 (122–159); hind foot, without claws, 33.4 (32–34); hind foot with claws, about 2.5 to 4 mm. more, or about 37. The 7 *largest* females: 312 (285–337); 169.6 (152–184); 136.7 (122–159); 33.4 (32–34). About three specimens in each series greatly exceed the others in size, and help to raise the average above the normal. The skulls show these specimens to have been much the oldest as well as the largest specimens of the series.

Mr. Vernon Bailey, in his 'Synopsis of the North American Species of *Sigmodon*' (Proc. Biol. Soc. Wash., XV, pp. 101–116, June 2, 1902), mistakenly adopted the name *mascotensis* for this species, and renamed my *S. colimæ*. *S. colimæ*, however, is the soft-haired reddish brown species he has named *S. alleni*. A reëxamination of my original material on which the two species, *S. mascotensis* and *S. colimæ*, were based (4 specimens of each), and topotypes of *alleni*, shows that all of the present Sinaloa examples represent *S. colimæ*, there being no specimens of *mascotensis* (=*alleni* Bailey) among them. Mr. Bailey says: "It is this species [*alleni*] Dr. Allen had in mind in writing his description of *mascotensis* from which he intended to separate the Colima form, but, as his two specimens of the species here named *alleni* were not fully adult, he unfortunately selected as his type another specimen that proves to be the same as the form to which on the following page he gave the name *colimæ*." On a casual consideration of the case with Mr. Bailey in Washington just before the publication of his paper, I assented that his interpretation of the matter was probably correct, but now on reëxamination of the subject, in the light of 70 specimens of *colimæ* before me and 4 of *mascotensis*, I find the type of the latter is not referable to *colimæ* but to the species he has kindly named in my honor, so that *S. alleni* is beyond question a synonym of *mascotensis*. My original descriptions, as well as the types and cotypes, show clearly the strongly marked differences between these two unusually distinct forms, for members of this genus.

The largest specimens of the present series (they are also very old, as shown by the condition of the skull and teeth) equal or slightly exceed in size *Sigmodon hispidus major* Bailey (type locality, Sierra de Choix, 50 miles northeast of Choix, Sinaloa), the range of which is given as "West coast of Mexico from Tepic to southern Sinaloa." I can look upon these large specimens of the present series, however, as merely old, very large examples.

12. **Oryzomys mexicanus mexicanus** *Allen.*

Thirty-eight specimens, 34 taken in the vicinity of Escuinapa, Jan. 30, Feb. 4 and 19, and 4 from Los Limones, April 22–26.

They are nearly all middle-aged or rather young, only two having the teeth much worn. The 9 largest specimens, all males, measure: Total length, 286 (257–305); head and body, 136 (127–146); tail vertebræ, 148 (140–160); hind foot without claws, 28.5 (26–30.5); ear from notch, 14.5 (12.7–16).

13. **Oryzomys melanotis** *Thomas.*

One specimen, Los Limones, altitude 3500 feet, April 24.

14. **Reithrodontomys tenuis** *Allen.*

Twenty-four specimens: Escuinapa, 22 specimens (8 are in formalin), Jan. 12, 30, Feb. 5, 6, 15, May 27, 30, July 7, 20; Los Limones, 1 specimen, April 25; Juan Lisiarraga Mountain, 1 specimen, April 30 (the last two are skins without skulls). Only 4 of the skulls have worn teeth; in all the others the tubercles of the crowns are wholly unworn, and the pelage is softer, grayer, and less fulvous than in the old adults with worn teeth. A litter of five quarter-grown young are labelled as taken Jan. 12.

Four old adults: Total length, 178 (175–181); tail vertebræ, 91 (86–98); hind foot without claws, 19; ear from notch, 14. The series from Escuinapa (13 specimens): Total length, 162 (153–181); tail vertebræ, 90 (83–98); hind foot, 17; ear, 14.

The Escuinapa specimens are practically topotypes, the species having been based on specimens from Rosario, about twenty miles north of Escuinapa.

15. **Perognathus pernix pernix** *Allen.*

Seventeen skins and skulls and 36 specimens in formalin, all collected in the immediate vicinity of Escuinapa, as follows: Jan. 6, 7, Feb. 3, 5, May 27, June 2, 15, July 7, 11, 15, 21, 22. Most of the specimens in formalin were collected on Hacienda Island, a few miles west of Escuinapa.

16. **Heteromys pictus escuinapæ** subsp. nov.

Type, No. 24502, Escuinapa, Sinaloa, Feb. 3, 1904; J. H. Batty.

Similar to *H. pictus* Thomas, but somewhat paler and grayer, with the posterior border of the nasals emarginate instead of truncate. Differs similarly in coloration from *H. plantinarensis* (Merriam), and also in smaller size, but agrees with *plantinarensis* in having the posterior border of the nasals emarginate instead of truncate.

In winter pelage this form is similar to true *pictus*, with a series of topotypes of which it has been compared, differing from it only in having the fulvous of the upper parts of a paler shade, and the gray rather more pronounced. When compared in series the two forms are very appreciably different. The same is true when compared with *plantinarensis*, but in either case it would be difficult to distinguish satisfactorily between single specimens by coloration. But *pictus* and *escuinapæ* are immediately distinguished by the skulls, through the markedly different form of the posterior end of the nasals, which are squarely truncate in *pictus* and V-shaped or emarginate in *escuinapæ*. This character proves constant in a large series of both forms, a glance at the nasals being sufficient to positively separate them.

H. p. escuinapæ, and probably all the forms of the *pictus* group, present two well-marked seasonal phases of pelage, so that in comparing specimens only those taken at corresponding seasons should be compared. The winter pelage, represented by 10 specimens taken in January and February, is paler and more fulvous than the summer pelage, represented by 16 specimens taken in April and May, the summer pelage being much darker and redder, in strong contrast with the winter pelage.

The collector's measurements of the type, an adult male, are: Total length, 216; head and body, 108; tail vertebræ, 108; hind foot (without claws), 24; ear from notch, 13. Nine adult males: Total length, 223 (203–235); head and body, 108 (101.6–114); tail vertebræ, 114.8 (105–123); hind foot without claws, 24.6 (23.8–25.4); ear from notch, 14 (12.7–15.9). Eight adult females: Total length, 211.3 (197–228); head and body, 103 (95–108); tail vertebræ, 109 (95–120); hind foot, 23.4 (22–25.4); ear from notch, 13.2 (11–14). About 2 mm. should be added to the length of the foot for the additional length of the claws. Measured dry, the hind foot, with claws runs from 26 to 29 mm.

Seven adult male skulls: Total length, 31 (29.5–32); greatest (or zygomatic) breadth, 14.6 (14–15.2). Four adult female skulls: Total length, 30.6 (30–31); greatest breadth, 13.8 (13.6–14.4). Five adult topotype skulls of *H. pictus*, 3 males and 2 females: Total length, 31.2 (30.3–32.5); greatest breadth, 14.4 (14–14.8). In these latter the largest and smallest skulls are both those of females.

17. **Lepus insolitus** *Allen.*

Thirty-six specimens (skins with skulls), and several additional separate skulls: Escuinapa, 35 specimens, Dec. 27, 30, Jan. 4, 14, 30, April 27, May 28, June 1–4, Oct. 10, 31; Arroyo de Taquaco (altitude 4000 feet), 1 specimen, May 10.

Collector's measurements of Escuinapa specimens : 10 adult males, total length, 479 (445–510); head and body, 443 (394–482); tail vertebræ, 46 (37–51); hind foot without claws, 87 (83–89); ear from notch, 73.5 (69–79): 10 females, total length, 475 (451–497); head and body, 429 (400–457); tail vertebræ, 47 (44–51); hind foot, 88.5 (82–92); ear from notch, 73.4 (70–77).

The single specimen from Arroyo de Taquaco (at 4000 feet altitude) is larger than any of the Escuinapa specimens, though nearly equalled in size by some of them. It measures, total length, 534; head and body, 483; hind foot, 89; ear, 73. Possibly further material would show that the form inhabiting the western foothills of the Sierra Madre is separable as a large race of *L. insolitus*.

Skull, 8 adult males from Escuinapa: occipito-nasal length, 81.6 (79–84); greatest zygomatic breadth, 37.5 (37–38.5); interorbital breadth, 19.4 (18–25); mastoid breadth, 31.6 (29.5–32); length of nasals, 36.6 (35–38): 6 females, occipito-nasal length, 81.3 (79–83);

zygomatic breadth, 37.9 (37.5–38); interorbital breadth, 19.7 (18.5–21); mastoid breadth, 30.4 (29–32); length of nasals, 36.3 (35–38). There is very little sexual difference in size, either in the external measurements or in the skull.

The series consists almost wholly of old adults, the only young specimens being three suckling young taken at Escuinapa the last of December and the first week in January, and three others taken as the same place Oct. 10. The series also represents both the winter and summer pelages. The latter does not materially differ from the former except in being rather more worn and somewhat faded.

This large Escuinapa series agrees perfectly with the type and topotype of the species from the Plains of Colima.

18. **Lepus alleni palitans** *Bangs.*

Twenty-one specimens, 11 males, 7 females, and 3 without indication of sex, all adult, December 18–27; vicinity of Escuinapa and Rosario.

"Found singly and in pairs, in the low open grassy lands, and in the open grassy foothills with patches of low bushes, to an altitude of 3500 feet. Most numerous on the foothills near the coast. The young appear usually in June. This 'Jack' is probable the most fleet of its genus. In running it will easily clear bushes four feet high."—J. H. B.

This Jack-rabbit belongs to the *Lepus alleni* group but differs so strongly from *L. alleni* that it probably will be found entitled to specific separation. These winter specimens, compared with winter specimens of *L. alleni* from southern Arizona, have the whole dorsal region very much darker and stronger yellowish brown, the sides are clearer, darker gray, the pelage much shorter, thinner, and less woolly, the feet and ears much less heavily clothed, and the yellowish white fringe bordering the ears much less developed. The limbs hence look slenderer and longer.

This species was described by Mr. Bangs (Proc. N. Eng. Zoöl. Soc., I, 85, Feb. 23, 1900) from two specimens collected by Mr. P. O. Simons at Aguacaliente, Sinaloa, a locality within the area in which the present series was collected. Mr. Batty's specimens are therefore practically topotypes of *palitans*. As Mr. Bangs's measurements were from dried skins, and relate only to the ear and hind foot, the following measurements, from fresh specimens, are of importance:

Eleven males: Total length, 613 (597–637); head and body, 559

(533–584); tail vertebræ, 55.5 (51–66); hind foot without claws, 128 (121–133); ear from notch, 149 (140–156). Seven females: Total length, 617 (587–648); head and body, 558 (533–584); tail vertebræ, 59.6 (51–70); hind foot without claws, 126.6 (121–133); ear from notch, 146.6 (140–156). These measurements are rather less than the corresponding measurements of *L. alleni*. In one specimen the expanse of the ears, distended laterally, is given as 14¾ inches (349 mm.).

Six skulls have an occipito-nasal length of 104 (103–107), and a zygomatic breadth of 46 (45–47). An old female gives a maximum for the series of 120 by 46.5.

I refer provisionally to this subspecies three additional specimens from Los Limones (altitude, 3500 feet), taken April 27. They are in worn and somewhat bleached pelage, and are thus not seasonally comparable to the Escuinapa series taken in December. They are paler and less varied with black above, and are considerably smaller, the collector's external measurements being as follows: Total length (3 specimens, all males), 557 (541–571); head and body, 506 (490–520); tail vertebræ, 51; hind foot, 123 (121–127); ear, 143 (140–146). The *largest* of these three specimens falls far below the *smallest* of the Escuinapa series of males, while the average is much less. There is less difference in the size of the skulls, which average 101 mm. in occipito-nasal length against 104 in the Escuinapa series. This indicates a somewhat smaller and perhaps separable race in the western foothills of the Sierra Madre, but further material is necessary to satisfactorily settle the question.

19. **Felis hernandezii** (*Gray*).

Five specimens, skins and skulls, immediate vicinity of Escuinapa, Aug. 16, 26, and Oct. 10. All are adults; 2 are males, 2 are females, and for one the sex is not recorded.

These specimens vary greatly in size, and also somewhat in age as shown by the skulls. Of the two males one is much older than the other, as well as much larger (the occipital portion of the skull is unfortunately broken, so that the length cannot be given); of the two females, while one is much older than the other, it is also much *smaller*.

"Ranges through western Mexico. Most common on the lowlands between the Pacific Coast and the western Sierra Madre range. One of the most pugnacious mammals of the cat family, often killing dogs much larger than itself. It frequently kills calves, pigs, goats, and sheep when smaller wild animals are not encountered. Nocturnal in habits, usually hiding away in high grass or up in high trees during the day. The female has from two to four young about July and August."—J. H. B.

Collector's measurements of 2 adult males: total length, 1766, 1727; head and body, 1156, 1105; tail vertebræ, 610, 622; hind foot without claws, 229, 229; ear from notch, 83, 86.

The coloration in four of the specimens is quite similar, although two were taken in August and two in October. The ground color is pale clay color and the dark markings are more restricted than in South American specimens, in which latter also the ground color is much deeper and more ochraceous. A single specimen, an adult male, from Achotal, Vera Cruz, now before me (No. 3674, Field Columbian Museum) is practically indistinguishable from the paler Escuinapa specimens, both in coloration and cranial characters, although it should represent the alleged subspecies *Felis onca goldmani* Mearns.

An imperfect skull (lacking both zygomatic arches) from Frontera, Tabasco, Mexico, differs from all the other Mexican specimens in its much greater size, as shown (No. 18061) in the subjoined table of measurements.

Fifteen skulls from various localities in South America (Paraguay, Parana, Bolivia, Brazil, Venezuela) indicate a similar wide range in size. These localities are as follows: two from Paraguay; one from San José, Parana; one from Jaguar Lake (on the boundary of Brazil and Bolivia); two from southern Brazil (Matto Grosso); one from Santarem, on the Amazon; four from the lower Amazon; one from Maripa, Venezuela; and several from unknown South American localities. The largest of all, with a basal length of 242 mm., is from Paraguay; the other largest South American skulls range in basal length from 203–214 mm., while the two largest Mexican specimens have a basal length, respectively, of 220 and 227 mm., and others range from 188 to 217 mm.

Dr. Mearns, in a paper on 'The American Jaguars,' published in 1901 (Proc. Biol. Soc. Wash., XIV, pp. 137–143, Aug. 9, 1901), considered the South American Jaguars separable from those of Central America and Mexico, on the ground of the presence in the former of a wider postpalatal fossa, differently shaped bullæ, larger size of the premolar teeth, and larger general size of the skull. These differences are mainly comparative, but for the most part are well-sustained by the present series of 24 skulls. One of the best distinctions is the width of the postpalatal fossa, which varies in the Mexican specimens (only 6 are measurable for this feature) from 20 to 23 mm., averaging 21.4, and in the South American (11 specimens) from 20 to 29 mm., averaging 27.8, with only one below 23 mm., while only one of the Mexican skulls (the largest) reaches 23. This is therefore a very constant and appreciable character, when it is considered that it is nearly independent of the general size of the skull.

While the Jaguar is unquestionably subject to a wide range of individual variation in size and coloration (aside from the sporadic black phase), as long since recorded by Wied for the Jaguar of southern Brazil, it seems evident that were sufficient material available for examination the *Felis onca* group would prove susceptible of separation into several easily recognized geographical forms; the material for any such study is, however, at present lacking in the museums of America. Dr. Mearns, as already stated, gave a number of characters which he believed, from an examination of the specimens in the U. S. National Museum, would serve to distinguish the Mexican and Central American Jaguars from those of South America. The alleged difference in the width of the postpalatal fossa in examples from north of the Isthmus of Panama as compared with South American specimens is, as said above, fairly constant and of considerable importance, but those based on the form of the bulla, on general size, and on the relative size of the premolars prove to be too inconstant to possess much value. His paper (cited above) on the Jaguars had especial relation to those of Mexico and Central America, which he considered specifically separable from those of South America, and also susceptible of division into several species and subspecies. *Felis hernandezii* (Gray) was considered as limited to the "arid tropical areas of Mexico," while the name *Felis hernandezii goldmani* was proposed for the form inhabiting the "humid tropical areas of Mexico," with the type locality, Yohatlan, Campeche. This supposed form, however, does not seem separable from true *F. hernandezii* (type locality, Mazatlan, Sinaloa), in view of the wide range of variation shown by the Escuinapa series of true *hernandezii*. His Central American *Felis centralis*, he calls the "smallest of the Jaguars"; it is, however, quite as large as the specimens before me from Venezuela and the Lower Amazon. In southern Brazil and Paraguay the size is nearly the maximum, equalling, if not slightly exceeding, the largest known specimens from Mexico.

The subjoined table of skull measurements shows the great range in size of Jaguars from Mexico, Costa Rica, Brazil, and southern South America.

MEASUREMENTS OF SKULLS OF THE *Felis onca* GROUP.

	Mus. No.	Sex and age	LOCALITY	Total length	Basal length	Zygomatic breadth	Mastoid breadth	Interorb. breadth	Foramen mag. to palate	Length of palate	Interpt. fossa, length	Interpt. fossa, width	Nasals, length	Nasals, greatest width	Distance between carnassials	Distance between upper canines at base	Width at outside base of canines	Length of upper premolar series	Length of upper carnassial	Length of pm^2	Combined length of pm^2 and pm^3
Mexican and Cen. American	25008	♂ old	Escuinapa, Sinaloa, Mex.	—	—	175	—	52.7	—	102	36	22.4	65	41	53.5	37	67	51	26.7	17	43.7
	25009	♂ ad.	" "	231	187	156	95	44	89	97	38	20	63	37	51	34.5	61.5	53	27.5	17	44.5
	25010	♀ ad.	" "	240	195	159	100	45	100	96	37	22.3	57	36	51	37	63.3	52.5	27.2	17	44.2
	25011	♀ old.	" "	208	170	142	86	41.5	68	82	25	—	51	34	46.5	32	56	48.5	24	15.3	39.3
	24689	♀ yg. ad.	" "	211	—	145	96	41	—	85	30	20	53	36	48	32	57.5	50	26	16.6	42.6
	6480N	♀ ad.	Colima, Mex.	—	181	156	95	45	90	91	26	—	53	36	53	31	63	40	25.8	16.2	42
	88914N	♀ ad.	San Blas, Mex.	—	—	150	—	46	—	87	28	—	55	37	54	34	61	48	24	16.2	40.2
	3674F	♂ old.	Achotal, Vera Cruz, Mex.	234	188	166	100	46	93	94.5	37	23	61	41.5	53	34	65		26	17	43
	18061	♂ old.	Frontera, Tabasco, Mex.	280	220	—	115	55	111	112	42	21	62	44	57	40	75.5	55	29.5	19	48.5
	100541N	♂ ad.	Palenque, Chiapas, Mex.	—	211	178	111	40	100	104	35		62	43	60	36	71	52	27	17.3	44.3
	[illegible]	♂ ad.	Tehuantepec, Mex.	—	217	188	112	51	111	100	36		67	46	57	36	69	50	25	17	42
	67493N	♂ ad.	San Andres, Vera Cruz, M.	—	227	180	113	50	115	111	36		66	48	58	39	72	54	27	18	45
	14177N	♂ ad.	Talamanca, Costa Rica	—	200	169	102	42.5	103	98	33	—	59	38	52.5	32	65	48	25.3	17.5	43
	14176N	♂ ad.	" " "	—	212	175	105	45	108	106	37	—	66	43	56	36.5	69	53.5	25.6	18	43.6
South American	4128N	♂ old	Paraguay	302	242	195	122	55	126	118	—	29	62	45	63.5	43	74	57	29	20	49
	4361N	♂ ad.	San José, Parana	258	212	175	118	44	107	104	46	29	67	41.5	61	40	61	61	31	20	51
	12296N	old	Paraguay	247	203	179	103	45	103	101	—	28	53	41	58	36	65	52	26.5	17	43.5
	4302N	old	Bolivia	260	205	170	104	51	104	103	—	26	60	44	60	39	70	55	28	18	46
	40303N	old	Santarem, Brazil	268	213	181	116	46	100	105	45	25	55	41.5	57	38	69	54.5	28	19	47
	3780	♂ ?old	Rio Belmonte, Brazil	—	—	183	—	—	—	—	—	—	—	29	—	—	—	—	29.5	—	—
	64	ad.	Brazil	224	—	153	91	40	—	92	30	20	55	32	51	—	—	50	26	17	43
	6204	old	South America	270	214	187	115	50	106	108	46	27	57	44	61	45	73	56	28	19	47
	11083	ad.	Lower Amazon	220	179	155	97	44	88	89	32	25	54	38	55	30	63	50	26	17	43
	11084	ad.	" "	226	171	153	100	42.5	83	90	—	23.5	56	38	51	29	62	52	28	19	47
	11086	ad.	" "	—	—	—	87	40	—	83	—	23	—	36	49	33	62	50	27	—	—
	16925	ad.	Maripa, Venezuela.	216	—	142	—	37	—	83	36	23	52.5	34	46	31	57	49	26	16	42

Note. — In the foregoing table the Museum number followed by N (*e. g.*, 6480 N) indicates that specimens thus indicated are in the U. S. National Museum. In like manner, 3674 F indicates that the specimen is in the Field Columbian Museum. All other numbers refer to specimens in the American Museum of Natural History. The measurements of the National Museum specimens of Mexican Jaguars are compiled from those given by Dr. Mearns (Proc. Biol. Soc. Wash., XIV, 1901, pp. 137–153). The measurements of the five National Museum specimens from South America were taken by myself, the specimens having been kindly loaned to me for examination by the authorities of the National Museum, through Mr. Gerrit S. Miller, Jr., Assistant Curator, Division of Mammals.

The method employed in taking the above measurements needs no explanation, further than to say that 'basal length' is the basal length of Hensel; and to add that 'length of palate' and 'foramen magnum to palate' are taken not from the median palatal notch, nor from the points bordering the notch, but from that portion of the posterior border between these points and the lateral wall of the interpterygoid fossa. The form of the posterior border of the palate varies individually and with age; usually there is a median V-shaped notch that penetrates more or less deeply into the border; on each side of the notch the border is produced posteriorly into a more or less long, spine-like process, between which and the lateral margin of the bony palate the border may be either slightly or deeply hollowed, and it is from this part of the border that the two above-mentioned measurements are taken. In young and middle-aged specimens, the median notch and the lateral hollows are usually deeper than in very old specimens, in which they have been filled out, more or less according to the individual, by the gradual deposition of bony matter at the posterior border of the palate with increase of age.

The basal length varies in 7 old males from Mexico from 187 to 220 mm., with 2 Costa Rica specimens at, respectively, 200 and 212; 3 Paraguay and Bolivia specimens range from 203 to 212, with a fourth at 242; other adult to old specimens (sex unknown) are somewhat smaller.

The width of the interpterygoid fossa varies in 6 Mexican specimens from 20 to 23, averaging 21.4; while the same measurement in 5 specimens from southern South America ranges from 25 to 29, averaging 27.4. The basal length of the skull in these two series is, respectively, 200 and 214, — the variation being quite out of proportion to that of the width of the interpterygoid fossa. The dentition is appreciably heavier in the South American skulls, pm ^{2} averaging 1 mm., and the combined length of pm ^{2} and pm ^{3} averaging about 2.5 mm. greater. These cranial and dental differences, combined with the deeper, richer colors of the South American animal, satisfactorily show that the South American *Felis onca* and the North American *F. hernandezii* may be regarded as specifically separable.

20. **Felis pardalis albescens** (*Pucheran*).

Felis albescens Pucheran (in I. Geoffroy Saint-Hilaire), Voy. de la Vénus, Zool., 1855, pp. 137–153, and atlas, pl. viii. State of Arkansas.

Felis limitis Mearns, Proc. Biol. Soc. Wash., XIV, 1901, p. 146. Brownsville, Texas.

Felis pardalis limitis Bailey, N. Amer. Fauna, No. 25, Oct. 24, 1905, p. 166.

"Known in Sinaloa, Tepic, and Jalisco, along the lowlands of the Pacific coast, as *Tigrio* or little tiger. A common species, widely distributed. Inhabits all kinds of country, stragglers having been taken as high as 9000 feet above sea level. Most numerous on dry hummocks and ridges about lagoons and swamps, especially in the dry season. Feeds on rabbits and other small mammals, birds, iguanas, frogs, fish, crabs, and small turtles. Hunts principally at night, though it is often met wandering about in the daytime. Has usually three or four kittens." — J. H. B.

Twenty-four specimens, 18 males and 6 females, all from the immediate vicinity of Escuinapa except 3; collected as follows: Escuinapa, Jan. 14, 16, Feb. 16–29, March 4–6, April 11 and 19, May 17, 26, 30, June 2, 21, 30, July 21, Sept. 1; Los Pieles, 2 specimens, April 11, 19; Los Limones, 1 specimen, May 17. All are adult, except one half grown and two quite young kittens. With the exception of five flat skins bought of hunters, the specimens are well prepared, with skulls, and with external measurements taken from the fresh specimens.

The series presents an excellent opportunity for the study of seasonal and individual variation. The seasonal variation, however, is quite overshadowed by individual variation, which has a wide range in respect to the general color and the size and pattern of the dark markings. Winter specimens are fresher and brighter looking than late spring and summer specimens, which have become more or less worn and faded.

Independently of season, specimens vary in the tone of the ground color from pale fulvous gray to quite strong fulvous, none, however, approaching the rich, bright fulvous of Vera Cruz specimens. The markings may be small and sparse, mainly in the form of spots and half-rings, without any marked tendency to form lines, or coarser and more prominent, especially over the middle of the dorsal area, where they have in many specimens a tendency to form interrupted black lines. The variation in both the ground color and in the size and form of the markings thus covers a wide range, but the extremes are connected by intermediate variations.

There is also great variation in size, both in the skull and in external measurements, as shown in the accompanying table of measurements. The skulls vary greatly in the length and form of the nasals, which range in length on the median line from 22 to 26 mm., and in greatest anterior breadth from 16 to 18 mm., in skulls of practically the same general size. Also the nasals may terminate posteriorly in a long narrow point or end abruptly.[1] The interpterygoid fossa varies widely in size and form, the notch in the posterior border of the palate being either shallow and broadly rounded or much deeper and more V-shaped. The pterygoid fossa is even more variable, and the lateral shelf may be very broad, with a breadth of 3 to 5 mm., or practically obsolete. These differences are so great that if the extreme specimens came from widely separated localities they might easily be taken as of considerable importance.

In the following table of measurements the specimens are arranged in the sequence of size, based on the basal length (Henselian) of the skull, the largest being placed first. The specimens are all from the vicinity of Escuinapa, and all adult, though some are much older than others; a few have well developed sagittal and occipital crests, but others with undeveloped crests exceed them in size.

Specimens from Brownsville, Texas, the type locality of *Felis limitis* Mearns, and from Arizona and Chihuahua do not differ essentially from the Escuinapa series. Unless the Ocelot formerly inhabiting Arkansas was different from the Ocelot of the Lower Rio Grande, Arizona, and northern Mexico, which is not probable, the proper name of this pale northern form of the *pardalis* group is *albescens* of Pucheran, who based the name on a male specimen "de l' état d' Arkansas, dans la Louisiane," sent by the well-known naturalist Trudau to the menagerie in Paris. His description, which is very detailed (*l. c.*, pp. 142–149), with measurements, and accompanied by a colored figure, agrees unquestionably well with the Texas animal. His belief that the Arkansas animal was specifically identical with that previously described by F. Cuvier under the name *Felis brasiliensis* — a name which is both unidentifiable and preoccupied — does not invalidate Pucheran's name, based on an Arkansas specimen and not at all on Cuvier's description and figure. The proper name of the northern pale form of *Felis pardalis* is therefore *Felis pardalis albescens* (Pucheran).

---

[1] The variation in the size and form of the nasals is relatively as great as in *Odocoileus sinaloæ*, as shown in Plates XXI–XXVI in the present paper. The present series of Ocelot skulls furnishes, in fact, quite as impressive an illustration of individual variation in these features as that afforded by the Sinaloa, Deer.

MEASUREMENTS OF *Felis pardalis albescens*.

Mus. No.	Sex	DATE	EXTERNAL					SKULL		
			Total length	Head and body	Tail vertebræ	Hind foot	Ear from notch	Total length	Basal length	Zygom. breadth
24069	♂	Jan. 16.	1028	660	368	152	57	131	118	92
24852	♂	June 21.	1154	779	375	159	54	138	116	92
24647	♂	Feb. 19.	1048	730	318	140	51	134	111	94
24648	♂	Feb. 29.	978	648	330	140	51	121	111	85
24661	♂	June 2.	1054	724	330	138	63	131.5	108.5	88
24660	♂	May 30.	997	673	324	137	54	129.5	108	88
24662	♂	Jan. 2.	1061	743	318	138	51	129	108	84.5
24655	♂	May 17.	965	673	292	140	63	126	103	85
24650	♂	March 6.	982	671	311	146	57	125	103	81
24659	♀	March 4.	1048	737	311	133	52	122	102	83
24068	♂	Jan. 14.	960	627	333	151	54	122	101.5	77.5
25007	♂	Sept. 1.	927	622	305	137	64	121	101	85
24663	♂	Jan. 2.	1009	698	311	137	46	120	99	84.5
24649	♂	March 4.	——	——	——	——	—	119	99	81
24653	♀	April 11.	——	——	——	——	—	119	98	84
24658	♂	May 26.	924	609	315	137	61	120	97	74
24651	♀	May 26.	——	——	——	——	—	118	97	85
24851	♀	June 9.	1002	673	329	133	54	117	96.5	82
3448(1)	♂	Jan. 21.	1130	760	370	150	58	130	118	91.5
3450(1)	♀	Jan. 27.	1115	745	370	155	60	133	113	86
3868(2)	♂	April 16.	1180	745	435	165	63	145	124	98

(1) Nos. 3448 and 3450, Field Col. Mus., Achotal, Vera Cruz, Mex.; *Felis pardalis* Linn.

(2) No. 3868, Field Col. Mus., Reforma, Oaxaca, Mex.; *Felis catenata* Ham. Smith.

21. **Felis oregonensis aztecus** (*Merriam*).

Three specimens: Savinella, a mining camp 20 miles east of Escuinapa, altitude about 3000 feet, young female, skin and skull, March 14; Los Pieles, 2 flat skins with skulls, April 19, 21.

There are no external measurements. The female is not fully adult. The skull of an old male measures as follows: Total length, 182; basal length, 150; zygomatic breadth, 133; mastoid breadth, 75; length of upper carnassial, 22. Another adult skull, smaller and probably a female: Total length, 167; basal length, 113; zygomatic breadth, 70; upper carnassial, 21.

In general coloration the three specimens differ but little, all being pale fulvous brown on the sides, and more reddish brown along the mid-dorsal area, in one with a slight mixture of blackish. Ears black or blackish, narrowly edged with gray.

22. **Felis cacomitli** *Baird.*

Two skins with skulls, and an additional skull, Hacienda Island, June 2, and Escuinapa, Feb. 28 and June 30.

Only one of the specimens, an old male, has external measurements, as follows: Total length, 963; head and body, 645; tail vertebræ, 318; hind foot without claws, 147; ear from notch, 51. The 3 skulls, probably all males (of one the sex is not given), measure as follows: Total length, 91 (♂), 97, 101 (♂); basal length, 97, 90, 89; zygomatic breadth, 58, 64, 67; interorbital breadth, 28, 29, 3.15; mastoid breadth, 37, 38.5, 39.

One of the skins is in the deep reddish phase, the other is intermediate between the typical red phase and the typical gray. The red example is like specimens in the red phase from Brownsville, Texas.

The species is evidently rare or more specimens would have been secured.

23. **Lynx ruffus escuinapæ** *Allen.*

Fourteen specimens, all from the immediate vicinity of Escuinapa, and hence topotypes of the subspecies, taken as follows: Jan. 10, 17, Feb. 10, 17, 23, March 3, 5, April 3, Aug. 16, Sept. 5, Oct. 7. Of the 14 specimens 9 (7 males, 2 females) are adult and 5 are young. Two of the young ones, taken Aug. 16 and Sept. 5, were about a month old when killed, and the other three, taken Oct. 7, were probably about a week old.

The collector's measurements of 7 adults (2 have no measurements) are as follows: 5 males, total length, 856 (837–870); head and body, 681 (673–698); tail vertebræ, 175 (165–184); hind foot without claws, 167 (156–178); ear from notch, 71 (64–76): 2 females, total length, 813, 813; head and body, 654, 635; tail vertebræ, 159, 178; hind foot, 159, 159; ear, 67, 70.

Eight adult skulls measure as follows: 4 males, total length, 127 (122–133); basal length, 104 (102–107); palatal length, 44.7 (43–47); postpalatal length, 58.3 (58–59); zygomatic breadth, 85 (83–87); mastoid breadth, 54 (52–55); length of pm2-3, 22.7 (22–23): 4 females, total length, 116 (114–120); basal length, 94.8 (93–99); palatal length, 40.8 (39–43); postpalatal length, 52.6 (51–56); zygomatic breadth, 78.2 (76–80); mastoid breadth, 51.5 (49–53); length of pm 2-3, 22.2 (21.2–23).

A series of 10 skulls from Texas (3 from Brownsville, 1 from

Rockport, 6 from San Antonio) are larger by 2 to 3 mm. in all of the above measurements, with disproportionately heavier dentition, the upper premolars in 6 adult males averaging in length on the alveolar line 24.9 as against 22.7 in the 4 adult male Sinaloa skulls, or 2 mm. more. A series of 5 adult Arizona skulls agree closely with the Texas series in general size and in the heavy dentition, pm 2-4 having a length of 24.8 mm.

Although nearly all of the ten adult specimens (including one obtained in December, 1896) were taken in winter (Jan. 10–March 5), they present a great range of color variation, four being in the gray phase, three in the red, and the others are variously intermediate. The gray specimens agree with the type, except that the soles of the hind feet vary from intense black to slightly blackish, or merely dusky as in the type. The pelage is short and coarse, quite different from that of its northern allies. The red phase is much less red than in Arizona specimens (*Lynx ruffus baileyi*).

The five young specimens are all in the soft, woolly first coat. They are all dingy grayish brown above, except one which is slightly reddish, with the dark spots and markings of the adult faintly indicated; the ventral surface is whitish, blotched with blackish.

"Known as the *Mojoquan* on the western slope of the Sierra Madre and the lowlands along the Pacific coast of Mexico. A shy, wandering species, widely distributed, and seldom encountered in the daytime, except when it is searching for water in the *varano* or dry season. Feeds principally on rabbits and other rodents, iguanas, crabs, and frogs. An expert hunter, and a hard fighter when wounded or at bay. Usually rests in high grass or thick bushes during daytime, in warm weather, and in caves and hollow trees in winter. Females have from three to five kittens." — J. H. B.

24. **Canis vigilis** *Merriam.*

Nine specimens, vicinity of Escuinapa, Feb. 5, 18, March 4, April 5, May 31, June 9, 15, July 30, Sept. 4. Five males and 4 females; one of the males is without measurements and another male (the September specimen) is only about two-thirds grown.

Collector's measurements: 3 males, total length, 1162, 1182, 1197; head and body, 851, 845, 889; tail vertebræ, 311, 337, 318; hind foot without claws, 194, 181, 191; ear from notch, 114, 102, 102: 4 females, total length, 1060, 1073, 1124, 1248; head and body, 749, 762, 800, 873; tail vertebræ, 311, 311, 324, 375; hind foot, 191, 181, 178, 181; ear, 114, 105, 108, 111.

The principal measurements of 4 male skulls and 3 female skulls are as follows:

Mus. No.	Sex	Total length	Basal length	Zygomatic breadth	Mastoid breadth	Upper pre-molar-molar series	Length of upper carnassial
24860	♂	192	167	95	59	70	20
24671	♂	208	178	98	62.5	75	21
24672	♂	205	175	103	65	69	20
24811	♂ old.	204	174	97	65	72	20.5
24812	♀	187	162.5	93.3	56.7	68	19
24670	♀ old.	183	160	88	60	66	19
24673	♀	191.5	166	92.6	60	69	20.2

There is another specimen collected by Mr. Batty at Escuinapa in December, 1895. The winter skins have a very full, heavy pelage, the coarse, long, black-tipped hairs of the upper surface giving a decidedly blackish appearance to the greater part of the dorsal region. The back of the ears, fore legs, and posterior surface of hind limbs are deep rusty red. In summer skins the pelage is greatly worn, the black-tipped hairs having mostly fallen out or been worn off, leaving the prevailing color strongly fulvous, with the nose, nape, and limbs rich rusty fulvous.

The contrast in coloration between this species and *C. impavidus* of northern Durango is striking at all seasons. The later species is also rather smaller than *C. vigilis*, with weaker dentition, and especially smaller carnassials.

25. **Urocyon cinereoargenteus scotti** (*Mearns*).

Eleven specimens: Rosario, 1 specimen, Dec. 21; Escuinapa, 9 specimens, Jan. 6, March 11, April 12, May 1, June 9; Papachal, 1 specimen, Dec. 7.

The series consists of middle-aged adults, except two very old males, one of which greatly exceeds all the other males in external measurements, and has also the largest skull.

Collector's measurements: 5 adult males, total length, 981 (927–1067); head and body, 566 (559–584); tail vertebræ, 415 (368–483); hind foot without claws, 125 (121–133); ear from notch, 71 (67–76): 4 females, 931 (927–947), 550 (546–559), 381 (368–394), 121 (114–127), 71 (70–76).

Skulls: 6 males, total length, 119 (114–125); basal length, 105 (102–108); zygomatic breadth, 64 (61.5–65); mastoid breadth, 42 (41.5–43): 3 females, 117 (116–118), 105, 43.

"Most common on uplands. Is quite tame in some localities and easy of approach. Hunts mostly at night, occasionally uttering a hoarse bark. Feeds largely on wild figs, fruit of the coporno, and berries; also on small rodents, grasshoppers, and beetles. It is an expert climber and usually goes up a tree when hard pressed by dogs. Female has from four to six young."—J. H. B.

26. **Ursus** sp.

Represented by a single imperfect skin, purchased of a native hunter, taken in the vicinity of Escuinapa.

27. **Conepatus sonoriensis** *Merriam.*

Fifteen specimens, Escuinapa and immediate vicinity, Feb. 5–March 1, and one each July 5 and Nov. 4.

Collector's measurements: 5 males, total length, 729 (647–833); head and body, 416 (368–457); tail vertebræ, 313 (267–381); hind foot without claws, 72 (64–76); with claws about 8 mm. more; fore claws, 13–15; ear from notch, 26 (23–29): 7 females, total length, 634 (584–697); head and body, 374 (292–392); tail vertebræ, 279 (242–305); hind foot without claws, 69 (64–76); ear from notch, 24 (23–25).

Skull: 5 males, total length, 81.4 (76–85); basal length, 66.5 (62–71); zygomatic breadth, 48 (43–53); mastoid breadth, 41 (38–43): 4 females, total length, 78 (75–80); basal length, 63 (61–65); zygomatic breadth, 45.7 (41.5–49); mastoid breadth, 40 (38–41.5).

In the average females are decidedly smaller than males, but the range of individual variation is so great that the two sexes distinctly overlap in size, the larger females equalling the smaller males.

The measurements given above are from adult examples, but only three or four have the worn teeth and other characters of old age; the greater part are middle-aged or young adults. While not differing appreciably from the large series of Jalisco specimens of this species, they average slightly larger, due apparently to the age of the latter averaging younger.

The old specimens taken in February are in worn faded pelage, the black of the sides, limbs, and ventral surface being a dull brown black in strong contrast with the deep black of the younger examples. The black at the base of the lower surface of the tail varies in amount from entire absence (in two specimens) to, in the average, about an inch in extent, varying to an inch and a half to two inches in extreme cases, with also in a few specimens a few short black hairs mixed with the white on the sides and lower surface of the basal third of the tail, generally quite inconspicuous.

"Probably the most common Mexican species of skunk. Most abundant on upland llaños at about three to five thousand feet altitude. Nocturnal, though on one occasion seven were observed in a band, traveling over a mountain shaded by heavy timber at midday. During the dry season they become more common near the coast, having migrated from the higher country eastward where food had become scarce. Food consists of insects, especially crickets, the parasites of which infest the bodies of the skunks by hundreds. Some individuals taken had their intestines, stomachs, and bodies so badly perforated that they were nearly dead from the effect. Breeds irregularly, probably according to age. Female has from three to six young." — J. H. Batty.

28. **Procyon hernandezii** *Wagler.*

Procyon lotor, variété mexicaine I. Geoffr. St. Hilaire, Zoöl. Voy. de la Venus, V, Pt. I, 1855, 125, atlas, pl. vi. Mazatlan, Mexico.

Procyon hernandezii var. *mexicana* Baird, Mam. N. Amer., 1857, 215 (at least in part); U. S. and Mex. Bound. Surv., Zoöl., Mamm., 1859, 22.

Forty-six specimens, Escuinapa and vicinity, Jan. 6–28, Feb. 17–28, April 6–19, June 8, 30.

The series includes a few old adults with worn teeth, and there are a few quite young specimens, but the larger part consists of young adult and middle-aged animals. The external measurements of a good series of adults are as follows:

Collector's measurements: 10 adult males, total length, 828 (775–889); head and body, 530 (483–559); tail vertebræ, 298 (279–330); hind foot without claws, 120 (114–127); ear from notch, 58.5 (57–64). Only 2 fall below 800 mm. in total length, only 1 below 500 in length of head and body, and only 1 below 290 in length of tail vertebræ. These are in each case rather young adults. Females, 10 adults, total length, 812 (762–869); head and body, 522 (470–546); tail vertebræ, 290 (273–323); hind foot, 114 (108–127); ear, 57.5 (51–64).

Skull.—The principal skull measurements of the same specimens and a few others are: males, total length, 117 (114–124, and 1 at 132); basal length, 104 (98–114); zygomatic breadth, 73.3 (64–83, only 1 above 79); mastoid breadth, 60.4 (54.5–68); upper molar series, 22.4 (21.5–24): 12 females, total length, 116 (110–123); basal length, 103 (94.5–114, only 1 above 105); zygomatic breadth, 75 (65–81); mastoid breadth, 60.6 (55.5–66); upper molar series, 22.3 (21.3–24.5).

Adult skulls from New York State, comparable in age with skulls from Escuinapa, measure practically the same. In the Escuinapa series none have a well-developed sagittal crest, and only four or five have the teeth decidedly worn. A series from Fort Verde, Arizona (Mearns), are slightly larger, but they are very old, with well-developed sagittal crest and much worn teeth. The difference in size is obviously due to difference in age.

Specimens in fresh pelage are of course much darker and brighter colored than those in more or less worn pelage, in which the fulvous tints have faded, and the long black-tipped hairs of the dorsal surface have been partly shed or have the tips much worn. Aside from the seasonal difference the series is quite uniform in coloration. The number of black tail rings is usually six, counting the more or less indistinct basal ones, but excluding the black tip, but quite a number of specimens have seven.

Available material from eastern Mexico is insufficient to show whether the west coast animal differs appreciably from true *P. hernandezii.*

29. **Nasua narica molaris** *Merriam.*

(Plates XXVII—XXX.)

About 100 specimens, of which about 40 are fully adult, and the rest young, including 6 newly born, the others varying from about one-quarter grown to nearly full-sized young adults. The females predominate over the males, nearly as 2 to 1. All were collected at or near Escuinapa, as follows: in December, 20 specimens; in January, 19 specimens; in February, 32 specimens; in April, 16 specimens, and others in June, August, and September. The very young specimens were taken July 24.

The surprising feature of the series is the immense range of individual variation in coloration, the very wide extremes being connected by intermediate examples which fill every stage of intergradation. There is, on the other hand, only about the ordinary amount of individual variation in size and in cranial features. This large amount of material is thus valuable as serving to show what may be expected in the way of color variation in Coatis from the same locality, and also furnishes a good basis for the study of sexual and age difference in the skull. Considerable space is here given to an exposition of these features, in the belief that some of the results will be of interest in other connections.

The Coatis of western Mexico have been separated by Dr. Merriam[1] from those of eastern Mexico on the basis of "gray of the face more restricted; tail longer; molariform teeth, particularly the upper ones, very much larger and more massive." No measurements are given of either the skull or teeth. The type locality of the western form is Manzanillo, State of Colima, and I am indebted to Dr. Merriam for the use of two topotype skulls, a fully adult male and female, for comparison with the present material. I have also a small series of specimens from the southern coast region of the State of Vera Cruz, but only four of them are sufficiently mature for satisfactory comparison. In three of these the three upper molariform teeth (pm^4–m^2) have a combined length of 21 mm., and in the other a length of 22 mm. In the old male topotype the same measurement is 24 mm., and in the female 22 mm. The same measurement in 30 adult skulls from Escuinapa averages 22 mm., the extremes of the series being 20 and 23.3 mm., none of them reaching 24 mm., but 6 reach 23 mm. Apparently the west coast animal is slightly larger than true *N. narica* of the east coast, with rather heavier dentition. The Sinaloa series averages somewhat lighter in coloration in comparison with a dozen eastern specimens. But color is such a variable feature in this group that little weight can be given to it in discriminating races unless the material for comparison is extensive.

Specimens from various localities in the northwestern part of the State of Jalisco, from the Tepic border south to Ameca, aggregating some 50 specimens, are not distinguishable in dentition and cranial characters from the Escuinapa series.

The collector's measurements of 38 adults from Escuinapa are as follows: 14 males, total length, 1181 (1098–1264, with only 1 below 1100 and only 1 above 1200); head and body, 582 (533–629, with only 1 below 559 and only 2 above 610); tail vertebræ, 591 (496–635, with only 2 below 572, and only 2 above 610); hind foot without claws, 100 (89–108); ear from notch, 40.6 (38–44): 24 females, total length, 1103 (1041–1194, with only 3 below 1060 and only 3 above 1150); head and body, 538 (496–597); tail vertebræ, 565 (533–598, with 1 at 635, the only one above 598); hind foot without claws, 92 (81–102); ear from notch, 38 (32–44, only 4 below 38 and only 1 above 41).

---

[1] Merriam, Proc. Biol. Soc. Vol. XV, 1902, p. 68.

Add to the length of the hind foot, as given above, about 8–10 mm. for the length of the claws. The fore claws average about 22–24 mm. in length.

"Frequently found in bands. Sleep and breed in hollow trees. Tail carried vertically, with no curve at the end. Fight savagely with claws and teeth." — J. H. B. A number of the very old males are entered in the collector's catalogue as 'Solitarios,' implying that here as elsewhere[1] the old males separate themselves from the bands and live alone.

Individual Variation. — The skulls present an unusually small range of individual variation, although they vary greatly with age and sex in a number of important characters. The amount of individual variation in coloration, however, is rarely equalled in any wild species of mammal known to me.

A series of 32 specimens collected at or in the immediate vicinity of Escuinapa in February, and another large series obtained at the same place in April, may be taken in illustration. The gradations between the extreme types of variation are so complete that it is difficult to classify many of the specimens as belonging to any particular phase. Beginning with the darkest, which may be designated as the *black phase*, the whole animal is black or deep brownish black, except the ventral surface from the chin posteriorly to the breast, which is, as usual, white or yellowish white. In some specimens, however, there is also a broad blackish band across the upper part of the throat, but this frequently occurs in the lighter phases. The basal half of the pelage, including the underfur, is light grayish brown, lightest at the extreme base.

The opposite extreme, which may be designated as the *light phase*, has the general color of the upper parts pale yellowish brown, or pale reddish brown (in different specimens), with the basal portion of the pelage much lighter than in the black phase, and the light portion more extended apically, so that either only the tips of the hairs are light brown, or there is a narrow subapical zone of a darker tint with the tips of the hairs light gray or pale yellowish gray. In this phase only the feet are blackish, which even in the lightest specimens are usually quite black.

The most marked feature in the intermediate phases is the color of the top of the head, nape, and shoulders, which vary from blackish, with the tips of the hairs yellowish or golden, to deep ochraceous.

---

[1] See Allen, Bull. U. S. Geol. and Geogr. Surv. Territories (Hayden), Vol. V, No. 2, Sept. 6 1879, pp. 158–160, where the previous literature of the subject is summarized.

The extreme ochraceous-headed phase is the most striking and beautiful of all; but the color of these parts varies in different individuals from deep ochraceous to pale yellow or even very pale buff.

In what may be termed an average specimen, or better still as the *medium phase*, the general pelage is in effect brown or brownish with a superficial wash of lighter, which varies from yellowish gray to deep yellow. In such specimens the basal two-thirds of the pelage is light, usually pale yellowish white, with a more or less broad subapical band of dark brown or black, and the tips of the hairs light. The light tips become greatly reduced in extent by wear and exposure, but normally vary greatly in length, from a slight tipping to half an inch or more in length. In specimens approaching the 'black phase,' the light tips are yellow, and are mainly restricted to the top of the head and nape and to a narrow median band which becomes narrower posteriorly and often nearly or quite disappears behind the shoulders.

Very few specimens in a large series are near enough alike to be covered in a single detailed description. The following, however, may indicate to some extent the range of variation in the color of the head, nape, and shoulders. First is the black phase, in which, the hairs have no light tipping. Next come the blackish brown specimens, with the top of the head and most of the upper surface black or blackish, and the hairs of the nape, top of the shoulders, and a tapering band running posteriorly to about the middle of the dorsal region tipped with dull rather brownish yellow, most extensively on the nape and the mid area of the shoulders. Then come lighter specimens with the general coloration lighter and the light tips of the hairs longer — *i. e.*, brown with a slight veiling of yellowish gray, strongest on the anterior half of the body and especially intensified over the region of nape and shoulders through the greater length of the light tips. Next follow, perhaps, the major part of the specimens, in which the body coloration is nearly the same as in the last, with the light tips of the hairs generally longer. In these, however, there is a wide range of variation in the color of the tips of the hairs, which give the prevailing color to the top of the head, nape, and shoulders. In many of these specimens the top of the head is dull or pale wood brown, or dull drab, becoming lighter and more yellowish over the nape and shoulders; in others it varies from clear buff through various yellowish shades to ochraceous and 'ochraceous-rufous' (Ridgway), only a relatively small proportion of the specimens being of this last deep, intense shade of ochraceous. On the head the color, whatever it may be, extends nearly to the base of the pelage; on the nape and posteriorly, the hairs are basally light (varying in different specimens from soiled buffy gray to strong yellowish buff), with a broad subapical band of black, and a still broader terminal band of pale yellow to ochraceous, according to the specimen. In the series of very light specimens the light basal portion of the pelage extends nearly to the surface, the subapical dark band is much narrower and less dark, and is more heavily veiled by the long light tips of the hairs, which are distinctly whitish. In such examples the top of the head is of an extremely pale shade of buff, in rare cases almost yellowish white; on the nape and shoulders the yellowish shade is somewhat stronger, and the subapical dark band is narrower and browner—brown rather than black.

The facial markings vary correspondingly in the tone of the dark areas from brown to black, and the superciliary stripes and other light markings vary more or less in width and extent, and from dingy white to clear white. In all the phases the inner surface of the ears is either clear white or yellowish white; the outer surface conforms to the color of the adjoining parts.

The tail varies with the general coloration, being blackish throughout in the 'black phase,' yellowish or buffy in the extreme light phase, and variously intermediate in other phases, according to the general coloration, but always, except in the darkest specimens, gradually darkening about the middle to the end, the apical third being much darker than the basal third. In many specimens the tail is obsoletely ringed, the dark bands being only slightly darker than the adjoining intervals; they are generally most apparent on the middle third of the tail, and so slightly developed as to be noticeable only on close inspection.

That the above-described color variations are purely individual is evident from the fact that both sexes are about equally represented in all the phases, that the half-grown young share them equally with the adults, and that all occur at one and the same locality, and that all have been taken at practically the same dates,— in the December, January, February, and April series of from 15 to 30 specimens each.

Cranial Variation due to Sex and Age. — In view of the inconstancy of the coloration in the present series of Coatis from Escuinapa, due wholly to individual variation, it is surprising to find so little variation in the cranial characters of the same specimens that is not obviously due to differences of sex and age. In regard to sexual differences, the female is much smaller than the male. In old skulls, with worn teeth, the male exceeds the female (in the average) by about 4 to 5 mm. in the total length of the skull, while in the average, in strictly comparable middle-aged skulls of the two sexes, the male exceeds the female by about 6 mm. (about 4.4 per cent.) of the total length of the skull. In other respects, as regards size and proportions, there are, with the exception soon to be mentioned, no noteworthy differences, the middle-aged male skull exceeding that of the female in nearly all its dimensions proportionately with the difference in total length. There is no difference in the length of the upper molar series, nor in the size of the individual teeth.

In the male, however, the upper canines are two to three times the size of these teeth in the female, with a markedly greater difference in the size of the lower canines, which in the male are about five times larger than in the female. A corresponding increase in the stoutness and breadth of the rostrum and in the development of the lower jaw is of course entailed in the male by the excessive enlargement of the canines, which strongly recall the great development of these teeth in the pigs and peccaries.

In old age, however, the male skull becomes greatly specialized as compared with that of the female of corresponding age, or with that of the middle-aged male. At the stage when the entire milk dentition is still *in situ*, and m^1 has become functional, the skulls of the two sexes are practically indistinguishable. By the time the complete permanent dentition has been acquired, the sexual difference in size has become well-marked, and the very different character of the canines leaves no question as to the sex of the specimen. Otherwise than in size and the character of the canines, the skull of the young adult or middle-aged male does not differ from that of the female. Following this middle-age stage, the development of old age characters begins to differentiate the skull of the old male from that of the young male, and still more markedly from that of the female.

These old age characters are the development of occipital and sagittal crests and postorbital processes, and a marked constriction of the postorbital region of the skull. The teeth also become greatly worn, in some cases little but the roots remaining; but this feature is, of course, common also to very old females. The beginning of the development of the sagittal crest is about coincident with, or slightly precedes the first perceptible wearing of the tubercles of the teeth, and its growth thence continues as long as the animal lives, in very old animals reaching a height of 7 to 9 mm. Coincidently with the development of the crest the constriction behind the orbits gradually deepens, while at the same time the interorbital breadth increases. In middle-aged male skulls the average interorbital breadth is 3.5 mm. greater than the postorbital, while in old male skulls it is 4 mm. less, resulting in a most marked change in the contour of the middle region of the skull.

The female apparently never develops even an incipient sagittal crest; the occipital crests are much less pronounced than in the male; the postorbital processes are much less prominent, and there is no decrease in the postorbital breadth of the skull, so marked in the male. The increase in the interorbital breadth is only in ratio with the general increase in the size of the skull. The modifications due to sex and age are shown in Plates XXVII–XXX, and in the subjoined table of measurements.

In preparing this table of measurements, only fully adult skulls were utilized, and they were divided into four categories, as follows: (1) old males (8 specimens) with well-developed sagittal and occipital crests and more or less worn teeth; (2) fully adult males, middle-aged (6 specimens), without crests and with unworn teeth; (3) old females (8 specimens), all with the teeth greatly worn; (4) adult females, middle-aged (6 specimens), with the teeth unworn. Younger specimens (amounting to more than half of the total series), in which the milk dentition was in most cases not wholly displaced, were discarded as unavailable for comparative measurements. The principal points thus shown may be summarized, as follows:

Old males, 9 skulls: Total length, 135.3 (131–142.5); basal length (Hensel), 118.9 (115–125); palatal length, 80.8 (77–86); postpalatal length, 38.5 (37–40.5); zygomatic breadth, 73 (65–83); interorbital breadth, 30 (26.5–33); postorbital breadth, 25.8 (23–28.5); mastoid breadth, 49.5 (47.5–51.5); audital bulla (transverse and longitudinal diameters), 11.5 × 14.2 (10.5 × 12–11 × 15); premolar^4-molar^2 (last three molariform teeth), 22 (20.7–23); height of sagittal crest (in 7 out of 9 specimens), 6.9 (5–8.5).

Middle-aged males, 6 skulls: Total length, 130.1 (125.5–135.31); basal length, 113 (108–116); palatal length, 78.3 (75–80); post palatal length, 35.3 (33–37.5); zygomatic breadth, 63 (59–64); interorbital breadth, 26.4 (25.5–27); postorbital breadth, 29.7 (28–31.5); mastoid breadth, 46 (44–48); audital bulla, 10.2 × 13.2 (10 × 13–11 × 15); pm^4-m^2, 22.2 (21–23.3); sagittal crest, 0.

Old females, 8 skulls: Total length, 127 (121–133); basal length, 111.3 (108–120); palatal length, 74.6 (70–78); postpalatal length, 35.3 (34–37); zygomatic breadth, 65 (60–69); interorbital breadth, 28.0

MEASUREMENTS OF 30 SKULLS OF *Nasua narica molaris*, FROM SOUTHERN SINALOA.

Mus. No.	Sex	Total length	Basal length	Palatal length	Postpalatal length	Zygomatic breadth	Interorbital breadth	Postorbital breadth	Mastoid breadth	Audital bulla	Length of pm⁴–m²	Height of crest	Condition of teeth
24000	♂	139	120	80	40	74.5	31	25	49	11.7 x 15	22	7	Not worn.
24004	♂	133	115	77	38	83	33	25	49.5	10.5 x 13	21.5	8.5	Much worn.
24139	♂	133	117	79	38	77	29.5	23	50.5	11 x 13	20.7	6.5	" "
24138	♂	135.5	118	81	37	80	30.5	—	51.5	12 x 14	23	7	Not worn.
24596	♂	142.5	125	84.5	40.5	—	33	26	51.5	11 x 15	22	7	Slightly worn.
24631	♂	131	115.5	77	38	77	28.5	26	49	11 x 14	22	7	Much worn.
24645	♂	138.5	120	80	40	76	30	25.7	51.2	—	22.5	5	Slightly worn.
24597	♂	136	120	83	37	65	28	27	47.5	12 x 15	22	0	" "
24611	♂	135	119	86	38	70	26.5	28.5	48	11 x 15	22	0	" "
Average, 9 old ♂♂		135.3	118.9	80.8	38.5	73	30	25.8	49.5	11.5 x 14.2	22		
24001	♂	128	111	77	34	62	27	31	46	11 x 12	23	0	Not worn.
23991	♂	135	115.5	80	35.5	64	25.5	30	46	10 x 13	22	0	" "
24629	♂	125.5	108	80	33	59	25.5	31.5	44	11 x 15	21	0	" "
24610	♂	128	111	75	36	67	26.5	28	45.5	10 x 13	23.3	0	" "
24646	♂	131	116	78.5	37.5	64	26	30.5	48	11.4 x 12	22	0	" "
14331	♂	130	115	79.5	35.5	63	27	32	47.5	12 x 14.2	22	0	" "
Average, 6 ad. ♂♂		130.1	113	78.3	35.3	63	26.3	30.5	46	10.2 x 13.2	22.2		
14332	♀	123	—	72	—	67	24	29	45	—	22	0	Much worn.
24599	♀	128	120	76	34	64.5	28	29	44	10.5 x 14	21.5	0	" "
24002	♀	121	104	—	—	60	27	32	42.5	11 x 14	22	0	" "
24000	♀	130	111	76.5	34.5	66	30	33	46	11 x 14	20	0	" "
24603	♀	126	108	73	35	67.5	29.3	33	47	12 x 13.5	20	0	" "
23989	♀	133	114	78	36	64	30	31	46	10 x 13	23	0	" "
24602	♀	130.5	112	76.5	35.5	69	29.5	30	48	10 x 13	21.5	0	" "
24832	♀	125	110	70	37	64.5	29	—	45.3	11 x 15	23	0	" "
Average, 8 old ♀♀		127	111.3	74.6	35.3	65.3	28.4	31	45.5	10.7 x 13.8	21.6		
23977	♀	128	111	76	35	61	27	28	45	10 x 13	22	0	Not worn.
24598	♀	127	111	75	36	62	27	32	43	9 x 11	22	0	" "
23988	♀	125.5	108.5	74	35	61	26	31	45	9.5 x 11.5	21.5	0	" "
23981	♀	1[illegible]4	108	74	34	58	25	28	43	11 x 13	23	0	" "
24605	♀	124	108	74	34	60	27	31.5	44	9.5 x 11.5	22	0	" "
24636	♀	126	109	75	34	61	27	28.5	46	11.5 x 11.4	21.5	0	" "
Average, 6 ad. ♀♀		125.8	109.3	74.7	34.7	60.5	26.5	30	44.3	10.1 x 11.9	22		

(27–30); postorbital breadth, 31 (29–33); mastoid breadth, 45.3 (42.5–48); audital bulla, 10.7 × 13.8 (10 × 13–11 × 15); pm^4–m^2, 21.6 (20–23); sagittal crest, 0.

Middle-aged females, 6 skulls: Total length, 125.8 (124–128); basal length, 109.3 (108–111); palatal length, 74.7 (74–76); postpalatal length, 34.7 (34–36); zygomatic breadth, 60.5 (58–62); interorbital breadth, 26.5 (25–27); postorbital breadth, 29.9 (28–32); mastoid breadth, 44.3 (43–46); audital bulla, 10 × 11.9 (9 × 11–11 × 13); pm^4–m^2, 22 (21.5–23); sagittal crest, 0.

30. **Tayra barbara senex** (*Thomas*).

Two young specimens, Escuinapa, Nov. 10. These specimens, apparently not more than three or four days old, are provisionally referred to this subspecies. They are in an interesting stage of growth, but of course too young for satisfactory determination. From the shoulders posteriorly the pelage is wholly deep black; at the shoulders it is mixed with rufous, passing into nearly uniform rusty brown on the head and neck. There is a small blackish spot at the posterior base of the ear, and an indistinct blackish lateral face stripe.

31. **Lutra annectens** *Forsyth-Major.*

One specimen, a hunter's pelt, without skull or measurements, Provisionally referred, on geographical grounds, to this species, which was based on a skull from Rio de Tepic, about one hundred miles south of Escuinapa.

32. **Myotis** sp.

One specimen, skin without skull, Escuinapa, Oct. 27. Alar extent, 260; length, 51; tail, 30; forearm (in dry skin), 35. Membranes dark brown; ears light brown.

33. **Dasypterus xanthinus** *Thomas.*

Four specimens, an adult female with two young, and a third young one, Escuinapa, June 26. Alar extent, 337; length, 66; tail, 51. The young ones are in formalin.

34. **Balantiopteryx plicata** *Peters.*

Six specimens, 1 skin, and 5 specimens in formalin, Escuinapa, July 8, 18.

35. **Molossus sinaloæ** sp. nov.

Type, No. 24524, ♀ ad., Escuinapa, Sinaloa, Feb. 15, 1904; J. H. Batty.

Size of *M. pretiosus*, but very different in the size and form of the ears and in coloration; the braincase is also much narrower and higher and the dentition heavier.

Above dull dark brown; below much lighter, approaching grayish brown; ears and membranes dark brown. Ears small, transverse width across both (in dry skin) 18 mm. against 21 mm. in *M. pretiosus;* height, 13.

Measurements.—The collector's measurements from the fresh specimen are: Alar expanse, 324; head and body, 70; tail, 38. From skin: forearm, 43; 3d finger, 1st phalanx, 46; 2d ph., 20; 3d ph., 18; thumb very short, 6; foot, 16 Skull: Total length, 20; basal length, 14; zygomatic breadth, 12; width of braincase, 10; height of sagittal crest, 1.5; mandible, 14; maxillary toothrow (including canine), 7; lower toothrow (including canine), 8.

Represented only by the type, an old female with worn teeth.

This species is intermediate in size between *M. nigricans* and *M. obscurus*, being much smaller than the former and very much larger than the latter.

36. **Nyctinomus mexicanus** *Saussure.*

Eight specimens (in formalin), Escuinapa, July (?).

37. **Pteronotus davyi fulvus** (*Thomas*).

Two specimens (in formalin), Escuinapa, July (?).

38. **Spectrellum mexicanum** (*Miller*).

Two specimens, Escuinapa, July 4 and 9.

39. **Leptonycteris nivalis** (*Saussure*).

Eight specimens, Escuinapa, Oct. 6, 7, 22, 29. Four are in the dark phase of coloration and four in the light phase, both sexes being represented in each. Alar expanse, 356–368; length of body, 73–89; ear, 16.

40. **Glossophaga mutica** (*Merriam*).

Twenty-nine specimens, Escuinapa, July 5–18 (18 specimens), Oct. 29 (10 specimens), Jan. 19 (1 specimen).

The collector's measurements of 10 adult (July) specimens are: Alar expanse, 266 (254–276); length, 56 (53–58). Several of the specimens are strongly reddish, between which and the dull dusky brown phase there is every stage of gradation; the younger examples are sooty gray, the darkest of the series.

41. **Dermanura phæotis** (*Miller*).

Two specimens, Escuinapa, Nov. 9, July 20.

II.—MAMMALS FROM THE STATE OF JALISCO.

Mr. Batty broke camp at Escuinapa, Sinaloa, November 10, 1904, and moved south with his pack train of burros across the lagoon country, arriving at San Marcos, Jalisco, December 6. His first collecting camp was at Arroyo Gavalan, about 20 miles west of San Marcos, where collections were made from December 17–26, 1904. From January 1 to March 30, 1905, work was prosecuted from various camps at and near Amatlan de Cañas, practically on the boundary line between Jalisco and Tepic, at an altitude of about 5000 feet. Mr. Batty states in one of his letters that "Ojo de Agua, Palo Amarillo Estancia, Llano e Casco, Rio Ameca, etc. [=Rio Sta. Maria, Garabatos Arroyo de Plantanar], all local names not on maps, are near and about Amatlan de Cañas, Tepic." Some of them are just over the line in Tepic, others are on the Jalisco side of the boundary. He left Llano e Casco April 13, moving southward about 30 or 40 miles to La Cienega, Jalisco, where he worked for the next ten days. This camp is "on the tableland formed by the first or eastern range of the Espirito de Santos Mountains, at an elevation of about 7000 feet." "La Cienega," he says, "is one of the few places that have water during the dry season. In the llano and in the arroyos are many small springs, and a small swampy pasture; hence its name, La Cienega or The Swamp. Snow has appeared many times, and it is said that about forty years ago a heavy storm occurred, leaving nearly two feet of snow on the level. Hailstones are of frequent occurrence, even in spring and fall. The nights are always chilly, and during the dry season, from the middle of October to the middle of June, water sometimes freezes, and white frosts are common. The surrounding country is mountainous and very rocky, sparsely covered with pines and oaks."

His next station was in the Wakenakili Mountains, one day's journey from La Cienega, and at about the same altitude, which locality he describes as follows: "A small range of mountains running southeast; highest points about 7000 to 8000 feet. Bounded on the east by the large Arroyo de Colomos, and on the west by the deep cañon-like valley of the Rio Santa Maria. The mountains abound in cliffs and deep arroyos, and are sparsely timbered with small pines, oaks, and other trees. There are several springs that flow during the dry season, and in the arroyos bushes and trees fringe the water-courses."

The next camp was in the Sal se Puerdes, at the same altitude and not many miles distant from the Wakenakili Mountains. Sal se Puerdes is described as a very broken and very barren mountain range; "a half day's hunt was necessary to find a flat place a few yards square to camp by water. The country is very slightly timbered, with nothing but bare rocks in the arroyo bottoms. The country, in most parts, resembles a stone quarry."

La Laja, where he spent the next three weeks (May 16 to June 4), "literally means a flat ledge, and probably was so named on account of the many flat rocks. It is probably the highest llano, mesa, or tableland in the State of Jalisco, having an altitude of 9000 to 10,000 feet. It is situated between two sharp ranges of the Espirito de Santos Mountains. There is no water in the dry season on the llano proper, but there are many springs in the arroyos which never run dry. It is timbered with pines, oaks, junipers, and many other kinds of small trees. The nights are cool in summer, and light snows occur occasionally in the winter months. Heavy rain storms send bodies of water rushing down the valleys, twelve to twenty feet deep. You will hear a roar for a few minutes and then comes a deluge of rushing water, carrying with it even large boulders."

From La Cienega Mr. Batty proceeded to Tuxpan, about 150 miles southeast of La Cienega, and soon after began work in the Sierra de Colima. His localities in this region are Tuxpan, June 24–26; Volcan de Fuego, altitude 10,000 feet, July 5–31; Las Canoas, on the tableland, about 40 miles west of Tuxpan, at an altitude of about 7000 feet, August 4 to September 4, and September 20 to October 2 (about 300 specimens); Artenkikil, an arroyo near Las Canoas, September 5 to September 21; Volcan de Nieve, altitude 12,000–13,000 feet, September 4–18 (about 100 specimens); Tanko Riparti and La Joya are other localities on the Volcan de Nieve where a few specimens were obtained, at altitudes respectively of 10,500 feet and 13,500 feet. Timber line on these mountains is given by him as at about 13,000 feet.

Mr. Batty's collections in Jalisco were thus made at two points in the State, (1) in northwestern Jalisco within a short distance of the Tepic boundary, from December 17 to June 4, the mammals obtained at the various points in this region where collections were made numbering about 844; (2) in southern Jalisco, a little west of

Tuxpan, and in the Sierra de Colima, near the Colima boundary, from June 24 to October 2, where about 554 specimens of mammals were collected. The whole number of mammals from Jalisco included in this report therefore numbers altogether about 1,400 specimens, representing 48 species, of which 2 are herein described as new. Further collections, not yet received, were made by him in southern Jalisco before his departure to the State of Oaxaca, where he is continuing his work.[1]

The absence from this collection of specimens of *Oryzomys* and *Neotoma*, while *Sigmodon*, *Peromyscus*, *Reithrodontomys*, *Heteromys*, and *Perognathus* are well represented, is noteworthy, and not easily explained, except on the ground of their probable absence at the particular localities where the trapping of small mammals was vigorously prosecuted. The genus *Peromyscus* is represented by 5 species and over 250 specimens; *Sigmodon* by 2 species and over 60 specimens, *Reithrodontomys* by 2 species and 41 specimens, *Microtus* by 17 specimens, and *Heteromys* by about 80 specimens. *Oryzomys* and *Neotoma* would have hardly escaped the traps had they been present.

Only one representative of the Geomyidæ was taken — namely, *Platygeomys gymnurus* (52 specimens) — and this only in the vicinity of Zapotlan (the type locality), although Mr. Batty was urged to give special attention to this group. He reports that he tried to obtain them at various points, and observed at a few localities old 'signs' of what appeared to be extinct colonies. The only place where he saw fresh indications of their presence was where he found the large colony of *Platygeomys*. From other localities, in Durango and Lower California, he has sent large series of both *Thomomys* and *Neotoma*, especially of the latter, so that their absence from the Jalisco collections is the more surprising.

1. **Marmosa sinaloæ** *Allen*.

One specimen, Rancho Palo Amarillo, near Amatlan de Cañas, Tepic, Jan. 15.

2. **Didelphis mesamericana mesamericana** (*Oken*).

Ten specimens, all adult: Estancia, 6 specimens, Jan. 22, 26,

---

[1] Since the manuscript of this paper was sent to the printer, another collection has been received from Mr. Batty, containing about 120 specimens of mammals obtained at Los Masos (altitude 5800 feet) in southern Jalisco, and collected between October 5, 1905, and February 16, 1906. These add several species to the list, and are now included in order to complete the account of the Jalisco collections. Unfortunately Mr. Batty's notebook covering this period of his work has not yet been received, so that measurements and dates of collecting are not available for record. This later material raises the total number of Jalisco specimens to about 1520, and the number of species to 60.

Feb. 22, March 12, 17; Rio Sta. Maria, 2 specimens, Feb. 4; Wakenakili Mountains, 1 specimen, May 3; Las Canoas, 1 specimen, September.

Two of the Estancia specimens are in the black phase; all the others are in the gray phase.

Also Los Masos, 4 specimens (1 female, 3 males), all adult and all in the gray phase.

3. **Tatu novemcinctum mexicanum** (*Peters*).

Two specimens, Las Canoas, Aug. 12, 21.

4. **Tayassu angulatum sonoriense** (*Mearns*).

Four adults collected as follows: La Cienega, ♂ ad. (skull only), April 23; Wakenakili Mountains, ♀ ad., April 26; Volcan de Fuego, ♂ ad., July 16; Los Masos, 1 very old female.

The collector's measurements of the first three of these specimens are, respectively, total length, 901, 965, 934; head and body, 864, 914, 914; tail vertebræ, 37, 51, 20; hind foot, 190, 197, 190; ear, 89, 79, 95. Skulls, respectively, total length, 236, 238, 241; basal length, 178, 182, 189; palatal length, 130, 129, 134; width of rostrum, 29, 28, 30; zygomatic breadth, 95, 101, 107; postorbital processes, 69, 68, 75; width of braincase, 53, 54, 58; width of palate at m^2, 19, 21, 22; width of basioccipital, 17, 16.5, 21; upper molariform series, 61, 58.5, 63.5; audital bulla, 10.5 × 13, 11 × 13, 12 × 13.5. One of the skulls has the orbitosphenoids and adjacent parts inflated; in the other two they are normal (see *antea*, p. 201).

The Wakenakili Mountains specimen is strongly suffused with deep buff, especially on the sides of the head, sides of the neck, the chest, flanks, and shoulder stripes, which latter are unusually conspicuous. The Volcan de Fuego specimen is much less suffused, and the shoulder stripes are not prominent. This specimen, from the locality, should, perhaps, be referable to *T. a. humerale*, from Armeria, State of Colima, but it is not apparently distinguishable from average Sinaloa specimens (see *antea*, p. 203). The three Jalisco skulls find exact counterparts in the Escuinapa series.

5. **Odocoileus sinaloæ** *Allen.*

Eighty-two specimens: 14 skins with skulls, 8 additional skulls, and about 60 pairs of antlers. The skins with skulls were collected as follows: Estancia, 1 adult male, Jan. 24; La Cienega, 1 adult male, 1 adult female, April 16, 21; Wakenakili Mountains, 1 adult male, May 6; La Laja, 1 young adult male and 1 old male, May 19, 25; Volcan de Fuego, 3 males, 2 females, and additional skulls, July 8–28; Volcan de Nieve, 2 adult males, Sept. 7, Oct. 2. The antlers were collected mostly at La Cienega, La Laja, and the near-by Mesa de Cullutan.[1]

Of the 10 males (skins with skulls), 4 are more or less immature, two of them being about half-grown and the others young adults; of the 3 females, only one is an old adult, the other two being more or less immature. The collector's measurements of the adults are as follows:

Adult males, 6 specimens: Total length, 1422 (1373–1473); head and body, 1225 (1194–1282); tail vertebræ, 196 (179–203); hind foot, 377 (368–406); ear from notch, 152 (133–165). One old female: 1359, 1156, 203, 356, 140.

The subjoined table of measurements of skulls shows the same wide range of individual variation in all the principal dimensions as in the Sinaloa series (see *antea*, p. 207), with no average difference of any importance. In the Sinaloa series of 6 males the nasals average slightly larger than in the 5 males from Jalisco, but the nasals are so inconstant in size and form that a few more specimens added to either series might materially change the average. In all other measurements there is no appreciable difference.

MEASUREMENTS[2] OF 7 SKULLS OF *Odocoileus sinaloœ* FROM THE STATE OF JALISCO, MEXICO.

	25783 ♂	25052 ♂	26136 ♂	25781 ♂	26000 ♂	Aver'ge of 5 ♂ ♂	25578 ♀	25099 ♀
Condylo-basal length	229	225	232	225	227	227	212	221
Palatal length	149	149	146	142	148	147	136	143
Interorbital breadth	57	53	62	55	56	56.5	49	54
Postorbital breadth	85	72	82	81	76	79	61	62
Breadth at lower edge of orb.	110	102	113	106	100	106	01	99
Palatal breadth at m³	41	40	45	40	34	40	35	41
Distance between premaxilla and nasals	10	4	0	2.5	0	3.3	2	8
Nasals, length	71	72	72	70	66	70	67	64
" breadth anteriorly	23	18	18	16	18	18.6	14.5	17
" " posteriorly	26	20	23	27	24	25	18.5	22
Length of upper toothrow	65	70	67	67	65	67	68.5	66
" " lower toothrow	—	72	73	72	70	71	73	73
Antlers, length of main beam along external curvature	356	220	270	—	—			
Greatest expanse	315	223	280	—	—			
Number of points	3–3	3–3	3–3	—	—			
Condition of teeth	g. w.	s. w.	m. w.	s.w.	s. w.		n. w.	g. w.

---

[1] Also 7 specimens (skins and skulls), and 4 additional sets of antlers, from Los Masos. Six of the skins are very old females in the gray winter coat; the other is a young male in the red summer coat.

[2] For explanation of measurements see *antea*, p. 207. Condition of teeth: g. w. = greatly worn; m. w. = much worn; n. w. = not worn, s. w. = slightly worn.

MEASUREMENTS OF 15 PAIRS OF ADULT ANTLERS OF *Odocoileus sinaloæ*.

	25813	25817	25829	26138	25785	25441	25804	25791	25811	25795	25787	25786	25800	25827	25879
Length of main beam along ext'l curvature	300	355	315	325	410	380	285	325	287	264	277	250	310	370	375
Length in straight line from bur to tip	200	250	195	205	187	200	173	205	185	155	184	170	157	200	175
Greatest expanse (outside to outside)	400	307	304	205	360	360	275	300	264	292	250	287	275	290	405
Distance between tips of main beams	310	165	162	235	165(?)	185	182	197	138	192	100	187	112	93	217
Diameter of bur	40	35	39	40	34	35	33	34	33	35	33	33	38	40	33
Number of points	4–4	4–4	4–4	4–4	3–4	4–4	4–4	4–4	3–4	4–4	4–4	3–3	3–3	3–4	3–4

The accompanying series of photographic illustrations (Plates XXXI–XXXIII) serves to show the development of the antlers with age, and also individual variation in size and form at different ages. In order to complete the series for the earlier stages, it was necessary to utilize a few skulls from the Sinaloa collection for the first and second year stages. The others are all from the State of Jalisco, and nearly all from the extreme northwestern part of the State, near the boundary line between Tepic and Jalisco.

A comparison of the detached antlers with those still attached to skulls enables one to judge pretty closely as to the age of the antlers here selected for illustration. About seven stages of growth may be recognized, counting the frontal processes of the first year as one stage, as follows:

First stage, antlerless frontal processes (animals 8 to 12 months old). Second stage, a short slender spike (2d year animals). Third stage, a longer, heavier, usually simple spike, in rare instances slightly forked at the tip (animals of the third year). Fourth stage, small, slender, branched antlers, usually 3-tined (animals of the fourth year). Fifth stage.—Similar to the fourth, but antlers very much heavier, but as a rule 3-tined (animals in the fifth year). Sixth stage.—Like the fifth, but antlers much heavier, 3-tined or 4-tined (animals of the sixth year). Seventh stage. — Similar to the fifth, but antlers heavier and usually 4-tined (animals of the seventh year). It is probably not possible always to distinguish between antlers of the fifth and later stages, as large antlers of the fifth stage might easily be mistaken for small antlers of the sixth stage, and *vice versa.* Seventh stage.—This differs from the sixth only in the antlers being generally larger and heavier. No satisfactory determination can be made as to the age of the antlers after the sixth year. Probably in very old animals they are often smaller than in vigorous animals of the seventh to ninth years.

6. **Sciurus poliopus cervicalis** *Allen.*

Sixty-nine specimens: Tuxpan, 1 specimen, June 24; Volcan de Fuego, 61 specimens, July 5–31; Las Canoas, 1 specimen, Aug. 16; Tanko Riparti, 1 specimen, Sept. 26; Los Masos, 5 specimens.

The type of *cervicalis* was taken at Tonila, Jalisco, May 14, and has the nape patch and the rump more fulvous and less rufous than any specimen in the large series from Volcan de Fuego. A June specimen from Tuxpan, however, closely resembles it. Nearly all of the Volcan de Fuego specimens are in fresh pelage — very dark gray with the nape and rump patches very dark, often with only a little rufous suffusion, but generally distinctly suffused with rufous. In one specimen these patches are practically obsolete, they scarcely differing from the rest of the dorsal surface. In two or three others they are only faintly represented. In some specimens the lower surface of the tail is almost entirely deep black; in a few examples there is a slight mixture of yellow hairs along the median line of the lower surface of the tail, in this respect showing a slight approach to *S. p. colimensis* of the adjoining coast region.

The collector's measurements of 20 adult males average as follows: Total length, 499 (477–526); head and body, 253 (235–266); tail vertebræ 246 (230–266); hind foot without claws, 58.5 (56–60); hind foot with claws, about 66; ear from notch, 32 (30–35): 18 females, 501 (489–518); 252 (235–267); 248 (235–261); 58 (54–60); 31 (29–32). These measurements fall somewhat below those given by Mr. Nelson for 5 adults, namely 536, [268], 267, and (hind foot with claws) 64.4, — a difference of about 36 mm. in total length, due perhaps to different methods of measuring, but more probably to the fact that *all* of the Volcan de Fuego series, young adults as well as adults, is here included.

7. **Sciurus poliopus tepicanus** subsp. nov.

Type, No. 25258, ♀ ad., Rancho Palo Amarillo, near Amatlan de Cañas, Tepic, altitude 5000 feet, Jan. 1, 1905; J. H. Batty.

Top of head black varied with gray; nape patch a slight suffusion of pale fulvous, varying in different specimens from nearly obsolete to well-marked; rump patch similar but usually less distinct; rest of upper parts gray, much paler than in *S. p. cervicalis;* tail above with the hair broadly ringed subapically with black, and with long white tips; tail below with the hairs narrowly ringed with black and white, the white greatly prevailing; ventral surface white; feet gray; ears mixed gray and fulvous, with the usual large white spot at the posterior base. The tail below is sometimes buffy along the median line; and sometimes the back is very faintly suffused with buffy.

Measurements. — Type, ♀ ad., total length, 508; head and body, 254; tail vertebræ, 254; hind foot without claws, 60, with claws, 67; ear from notch, 32. The collector's measurements of 18 specimens (12 males, 6 females) average: Total length, 528; head and body, 263; tail vertebræ, 265; hind foot (without claws), 60; ear from notch, 32. Adult skulls average about 59 in total length, and 34 in zygomatic breadth.

Represented by 21 specimens, taken as follows: Rancho Palo Amarillo, near Amatlan, Tepic, 4 specimens, Jan. 1–7; Estancia, 5 specimens, Jan. 31, Feb. 2, March 4; Rio Sta. Maria, 3 specimens, Feb. 2, 7; Arroyo de Plantanar, 1 specimen, Feb. 17; La Cienega, 1 specimen, April 23; Wakenakili Mountains, 6 specimens, April 25–May 7; La Laja, 1 specimen, May 28. These localities are all near each other, along the territorial boundary between Tepic and Jalisco, at altitudes ranging from 5000 to 7000 feet.

These specimens vary from the type described above mainly in the greater or less distinctness of the nape and rump patches, which range from nearly obsolete to strongly developed, in most of the specimens they being well-marked. A few specimens, about one in five, show a slight suffusion of fulvous throughout the dorsal area, only slightly stronger on the nape and rump than elsewhere. These very closely agree with topotypes of *S. p. nemoralis* from central Michoacan, and were they all of this character the Jalisco and Tepic series might readily be referred to that form. One or two specimens show a slight infusion of pale yellow in the central line of the under surface of the tail, through the great reduction of the amount of black, which is much less than the amount of white, thus reversing in a marked degree the conditions in *cervicalis*. *Tepicanus* also is slightly larger — about an inch longer in total length — with a relatively longer tail, which slightly exceeds one-half the total length instead of falling slightly below one-half, as in *cervicalis*. The light colors of *tepicanus*, as compared with the dark colors of *cervicalis*, correspond with the semiarid conditions of the enviroment in the case of the former and the markedly more humid environment of the latter. That the difference in color is not seasonal is shown by a series of *cervicalis* collected in the Sierra de Colima at the same season as the Tepic and Jalisco specimens.

8. **Citellus (Otospermophilus) variegatus variegatus** (*Erxleben*).

Thirty-six specimens: Arroyo de Gavilan, Jalisco, 3 specimens, Dec. 17, 25; Estancia, Jalisco, 3 specimens, Jan. 28, March 3; Ojo de Agua, Tepic, 5 specimens, Feb. 15; Arroyo de Plantanar, Jalisco, 5 specimens, Feb. 17, 18, 20; Rio Ameco, Jalisco, 1 specimen, March

18; Garabatos, Tepic, 2 specimens, March 20; (all of these localities are within a few miles of the boundary line between Tepic and Jalisco;) Tuxpan, 1 specimen, June 24; Las Canoas (near Zapotlan), 16 specimens, Aug. 10–23 and Oct. 1.

The series consists largely of adults but includes 4 specimens (Ojo de Agua, Feb. 15) about one-quarter grown, and 4 (Las Canoas, Oct. 1) nurslings. The latter, all from apparently the same litter, are thinly haired, clear gray above, darker on the head, nape, shoulders, and anterior half of the back, and faintly suffused with brownish over the lower back and rump, and everywhere minutely flecked with black.

The collector's measurements of 9 adult males from the Tepic-Jalisco boundary are as follows: Total length, 545 (505–573); head and body, 308 (305–323, with one at 270); tail vertebræ, 235 (210–254), hind foot without claws, 61 (57–69); ear from notch, 24 (23–25). Four females: Total length, 493 (463–534); head and body, 272 (250–305); tail vertebræ, 222 (213–229); hind foot, 55; ear, 24.

The Las Canoas specimens are younger and smaller, but are otherwise similar. Specimens from Zapotlan, collected many years ago by Dr. Buller, are among the largest of the series, an old male skull measuring 68 mm. in total length by 42 in zygomatic breadth.

Very few of the Tepic and Jalisco specimens show any tendency to a blackish area on the head, as do specimens from the Valley of Mexico (the assumed type locality of *variegatus*) and Puebla. In northern Durango and thence northeastward into Coahuila, specimens (*C. v. rupestris*) without a conspicuous black cap are exceptional; further to the eastward and northward this form passes into the melanistic *C. v. couchi*. The form in western Mexico, ranging from Tepic and Jalisco into Michoacan, is almost uniformly gray-headed and very large. Unfortunately the form to which the name *variegatus* has now become restricted, is an intermediate phase between the small, light-colored, black-headed form of north-central Mexico and the large, dark-colored, gray-headed form of the south. As, however, the Tepic-Jalisco gray-headed form is very constant in its characters over a wide range, it seems as fairly entitled to a distinctive name as many other geographical forms now currently recognized.

9. **Citellus (Xerospermophilus) mexicanus mexicanus** (*Erxleben*).

Twenty-eight specimens, nearly all adult: Zapotlan, 1 specimen, July 25; Las Canoas, 27 specimens, Aug. 5–25.

Two phases of coloration are represented: most of the specimens are yellowish chestnut above varied with small white spots bordered with blackish, but about one in six are decidedly paler and more grayish. This difference proves to be purely individual and is not due to condition of pelage.

10. **Mus rattus** *Linn.*

Six specimens: 2 typical examples and 1 hybrid between *M. rattus* and *M. alexandrinus*, but with the characteristics of the latter the most pronounced, near Amatlan, Tepic, Jan. 16 and Feb. 15; Las Canoas, 1 specimen, very young, Aug. 26; Los Masos, 2 specimens, typical.

"Blue Rat. Common on the Pacific slope from Mazatlan into State of Jalisco." — J. H. B.

11. **Mus alexandrinus** *Geoffroy.*

Two very young examples, taken at Las Canoas, Sept. 1, and a half-grown one at Los Masos.

12. **Peromyscus melanotis melanotis** *Allen & Chapman.*

Fifty-four specimens, all from Volcan de Nieve, taken at an altitude of 12,500 to 13,000 feet (near timber line), Sept. 5–18.

These specimens are all in the dark pelage and look very unlike April and May specimens, in the red phase, from the type locality and points in the high tableland of the States of Vera Cruz and Hidalgo, at altitudes of about 8000 feet. I am especially indebted to the kindness of Mr. Osgood for their identification

13. **Peromyscus labecula** *Elliot.*

One hundred and forty-one specimens, collected as follows: Arroyo de Plantanar, Jalisco, 3 specimens, Feb. 18 and 19; Ojo de Agua, near Amatlan, Terr. Tepic, 4 specimens, Feb. 15; Garabatos, Jalisco, 1 specimen, March 27; Estancia, Jalisco, 5 specimens, Feb. 3 and 22, March 8, 11, and 17; Las Canoas, 113 specimens, Aug. 5–Sept. 1; Los Masos, 15 specimens.

14. **Peromyscus hylocetes** *Merriam.*

Six specimens, all adult, taken as follows: Volcan de Nieve, 1 specimen, Sept. 16; Tanko Riparti (10,500 feet), 5 specimens, Sept. 22–24; Los Masos, 1 specimen.

15. **Peromyscus spicilegus spicilegus** (*Allen*).

Three specimens, Arroyo de Gavilan, Jalisco, Dec. 16–18. These specimens are quite indistinguishable from Escuinapa examples, and are much paler than the rest of the Jalisco specimens. Arroyo de Gavilan is very nearly on the boundary between Tepic and Jalisco.

16. **Peromyscus spicilegus simulus** *Osgood.*

Twenty-nine specimens, collected as follows: Estancia, 1 specimen, Feb. 3; La Cienega, 4 specimens, April 18 and 25; Sal se Puerdes, 1 specimen, May 7; Wakenakili Mountains, 13 specimens, altitude 7000–8000 feet, April 27–29 and May 19; La Laja, 3 specimens, May 27; Volcan de Fuego, 7 specimens, July 9, 10, and 22–27.

The Volcan de Fuego specimens, from an altitude of 10,000 feet, are much darker and richer colored than the others, which are from the tableland, mostly from altitudes of 7000 to 8000 feet.

17. **Peromyscus (Baiomys) musculus** (*Merriam*).

Thirty-six specimens, collected as follows: Arroyo de Plantanar, 2 specimens, Feb. 19; Arroyo de Gavilan, 18 specimens, Dec. 19–26; Estancia, 7 specimens, Feb. 24 and March 10; La Laja, 1 specimen, May 20; Las Canoas, 7 specimens, Aug. 10-18; Tanko Riparti (alt. 10,600 ft.), 1 specimen, Sept. 20.

18. **Sigmodon hispidus colimæ** *Allen*.

Thirty-five specimens: Rancho Palo Amarillo, near Amatlan de Cañas, Tepic, 4 specimens, Jan. 13, 15; Estancia, Jalisco, near Tepic border, 10 specimens, Jan. 22, 25, Feb. 4, March 11; Ojo de Agua, near Amatlan, 1 specimen, Feb. 16; Rio Sta. Maria, Jalisco, 6 specimens, Jan. 13, 15, Feb. 1, 2; Las Canoas, near Zapotlan, 11 specimens, Aug. 6, 9, 15, 20; Artenkiki, 3 specimens, Sept. 10, 17.

Only 5 or 6 of the specimens taken in January and February are adult, 7 are less than one-fourth grown, and the others range up to one-half to two-thirds grown; the August and September specimens are all adult, except a litter of 7 nursing young, taken Sept. 20.

These specimens are not appreciably different from the large series from Escuinapa, Sinaloa (*cf. antea*, p. 209).

19. **Sigmodon vulcani** sp. nov.

Type, 26310, ♀ ad., Volcan de Fuego, Jalisco, alt. 10,000 feet, July 25 1905; J. H. Batty.

Similar in coloration to *S. toltecus* and *S. borucæ*, but smaller and with a very differently shaped skull — broad and short with a very broad braincase.

Above yellowish brown, less rufous than *S. toltecus* or *S. borucæ*, though not very distinctly different; ventral surface gray; sides of nose pale buffy; feet gray; tail decidedly blackish above, slightly grayish below.

Measurements. — Type, total length, 235; head and body, 140; tail vertebræ, 95 (slightly imperfect); hind foot without claws, 32; ear from notch, 22. Eight of the largest (adult) males measure, total length, 245 (238–257); head and body, 138 (133–146); tail vertebræ, 100 (102–111); hind foot, 30 (27–32); ear from notch, 21.4 (19–22). Eight of the largest (adult) females: total length, 248 (238–257); head and body, 140 (136–146); tail vertebræ, 108 (102–111); hind foot, 32 (30–34); ear from notch, 20 (19–22). An average adult skull (the type): total length, 34; basal length, 28; zygomatic breadth, 19; width of braincase, 14 (in several other skulls, 15).

Skull. — The skull is short and broad, in comparison with the other Mexican forms, the interorbital region being especially shortened, forming a very noticeable feature in comparison with *S. borucæ* and *S. toltecus*.

In *S. vulcani* the pelage is soft and full, and not at all bristly, in this respect resembling *S. mascotensis* (= *S. alleni* Bailey), but it is darker and more fulvous in coloration, and differs also from this species in the shortness and breadth of the skull, particularly in the short interorbital region and the more abrupt expansion of the braincase. The young in first pelage are especially darker than the young of *S. mascotensis* in the corresponding stages. Compared with the large *S. colimæ* of the neighboring tablelands, the differences in sizes, coloration, and shape of the skull are striking.

Represented by 29 specimens, all taken on the Volcan de Fuego at an altitude of about 10,000 feet, July 10 to 28, 1905. They are mostly adults or young adults, but include a small series of young in first pelage.

20. **Reithrodontomys tenuis** *Allen.*

Thirty-nine specimens: Amatlan de Cañas, Tepic, 7 specimens, Jan. 4–12; Rancho Palo Amarillo, near Amatlan, 12 specimens, Jan. 2–22; Ojo de Agua, Tepic, 3 specimens, Feb. 9, 10; Arroyo de Gavalan, Jalisco (on the Tepic boundary), 1 specimen, Dec. 21; Estancia, Jalisco, 5 specimens, Jan. 30, Feb. 3, 5; La Cienega, 1 specimen, April 25; Wakenakili Mountains, 2 specimens, April 27, 29; La Laja, 1 specimen, May 16; Las Canoas, about 20 miles west of Zapotlan, 7 specimens, Aug. 6, 13, 15; Los Masos, 1 specimen.

A large number of the specimens are immature, especially among those taken in December, January, and February, while those taken in August are all adult. These Tepic and Jalisco specimens do not differ appreciably from the large series taken near Escuinapa, Sinaloa.

21. **Reithrodontomys colimæ** *Merriam.*

Two specimens, immature, Volcan de Fuego, July 5 and 12.

22. **Neotoma sinaloæ** *Allen.*

One specimen, Wakenakili Mountains, an eastern spur of the Sierra Madre, May 1, 1905. This specimen is not appreciably different from topotypes of the species from southern Sinaloa.

23. **Microtus phæus** *Merriam.*

Seventeen specimens, about one-half fully adult, Volcan de Nieve (alt. 13,000 ft.), Jalisco, Sept. 5–18.

24. **Platygeomys gymnurus** (*Merriam*).

Fifty-two specimens: Las Canoas, near Zapotlan, Aug. 5–19. About 40 are in the red phase of coloration and 12 in the dusky phase, varying from plumbeous more or less suffused with dark chestnut to slaty black. They include all ages from very old to young less than one-fourth grown.

25. **Perognathus flavus mexicanus** *Merriam*

Seven specimens, Las Canoas, Aug. 9–22.

26. **Heteromys pictus pictus** *Thomas.*

Seventeen specimens, collected as follows: Rio Santa Maria, 8 specimens, Feb. 1–4; Wakenakili Mountains, 7 specimens, April 27, May 1, 8, 10; Sal se Puerdes, 1 specimen, May 10. These localities are near the Santa Maria River, in the high tableland and eastern spurs of the Sierra Espirito de Santos, at an elevation of about 7000 feet. Also 1 specimen from Estancia, Feb. 28, and 2 from Arroyo de Plantanar, Feb. 18 and 20.

In size, color, and all external characters these specimens are not distinguishable from either true *pictus* or the form named *plantinarensis* by Dr. Merriam. The nasals, however, are truncate posteriorly, as in *pictus*, and not emarginate, as in *plantinarensis* and *escuinapæ*. *Plantinarensis* is apparently a southeastward extension of the southern Sinaloa form I have named *escuinapæ*, with which it agrees in the form of the nasals, but it is smaller and brighter colored.

It is remarkable that the only positive character that will readily distinguish these three forms is the squarely truncated nasals in *pictus* and the distinctly emarginate nasals in *plantinarensis* and *escuinapæ*, all of which forms probably intergrade geographically. If the decided difference in the form of the posterior border of the nasals, in the absence of any other appreciable differences of size, form, number of toe-pads, or coloration, be considered of specific importance, then *pictus* will stand as a species, and *plantinarensis* also as a species with *escuinapæ* as a subspecies of the latter.

None of these 13 specimens are very old, being mostly young adults, and thus fall below true *pictus* in size, averaging practically the same as the *plantinarensis* specimens of corresponding age.

These two forms, as represented in the present series, are almost separated geographically, all of the specimens from the Wakenakili Mountains, Rio Santa Maria, and Sal se Puerdes, 15 in number, being true *pictus*, while all those from Ojo de Agua, Palo Amarillo, and Amatlan, 25 in number, are true *plantinarensis;* but of 11 specimens from Estancia, Jalisco, and 5 from Arroyo de Plantanar, one of the former and two of the latter, or 3 specimens out of 16, are true *plantinarensis* while the others are *pictus*. In about 3 skulls out of 53 the form of the posterior border of the nasals is irregular, being convex rather than truncate.

27. **Heteromys pictus plantinarensis** *Merriam.*

Forty specimens, collected as follows: Amatlan de Cañas and vicinity including the localities Ojo de Agua, Palo Amarillo, Estancia, Rio Ameca, Arroyo de Plantanar, etc. (local names not on maps, on the boundary between Tepic and Jalisco), Jan. 14 to Feb. 28. The various localities, some of them in Tepic and some in Jalisco, are represented as follows: Rancho Palo Amarillo, Tepic, 13 specimens, Jan. 2–4 and 13–16; Amatlan, Tepic, 9 specimens, Jan. 4–11; Estancia, Jalisco, 10 specimens, Jan. 23–31 and Feb. 1, 3, 6, 22, and 28; Ojo de Agua, Tepic, 3 specimens, Feb. 9, 14, and 16; Arroyo de Plantanar, Jalisco, 5 specimens, Feb. 18–20; Volcan de Fuego, 1 specimen, July 13. (This last specimen has no skull, and its reference here is thus necessarily provisional.)

Of these 40 specimens only 3 or 4 are very old, with worn teeth, the greater part being middle-aged or young adults, with a few still younger. Taking the skulls as a basis for comparison, the older specimens are as large as topotypes of corresponding age of *H. pictus*, having a total length (average of 4 specimens) of 31.8 and a mastoid breadth of 14 mm., or exactly the same as 4 topotypes of corresponding age of *H. pictus*. Young adult and middle-aged specimens range in total length from 28.5 to 30 mm.

The external measurements of 18 males, selected at random, are as follows: Total length, 214 (205–247); tail vertebræ, 112(98–133) hind foot without claws, 25.3 (24–27), to which about 2 mm. may be added for the claws. Females average slightly smaller, as follows: 13 females, total length, 203 (197–229); tail vertebræ, 105 (95–121); hind foot, 24 (22–27). The maximum dimensions given above indicate the size of old individuals, the low general average being due to the immaturity of the specimens forming the series as a whole, although in no case were specimens selected which had not mature dentition.

It thus appears that *H. plantinarensis* is not so very much smaller than *H. pictus* as Dr. Merriam supposed when characterizing the form from a single specimen, of which the present series are in part (practically all) topotypes.

The relationship of the two forms and their distribution as represented by the present material have been already considered under the head of *H. pictus*.

28. **Heteromys jaliscensis** sp. nov.

Type, No. 26325, ♂ ad., Las Canoas, about 20 miles west of Zapotlan, Jalisco, altitude 7000 feet, Aug. 6, 1905; J. H. Batty.

Near *H. canus* but much darker, the upper parts being dusky gray, with a slight admixture of fulvous; size smaller.

Type, total length, 232; head and body, 120; tail vertebræ, 112; hind foot (from dry skin), 27.5; ear from notch, 13. Skull, total length, 32; zygomatic breadth, 15. Four adult males average, total length, 228; 6 adult females average, total length, 210.

Compared with *H. canus*, the present species is much smaller, and is further readily distinguished by its much darker coloration. The skull has a relatively narrower braincase, and is nearly 2 mm. shorter and much lighter and less massive.

Represented by 4 adult males and 6 adult females from Las Canoas (near Zapotlan), an adult male and female and a young female from Arroyo de Gavalan, a young female from Arroyo de Plantanar, and a young female from Ojo de Agua. The last three localities are near Amatlan de Cañas, where it is apparently not common and of local occurrence, as of 80 specimens of *Heteromys* collected at these points only 5 belong to this species. It apparently ranges thence southward over the tableland to at least Zapotlan.

29. **Lepus floridanus subcinctus** *Miller.*

Sixteen specimens: Ojo de Agua, 1 specimen, Feb. 15; Estancia, 2 specimens, Feb. 21, March 17; Garabatos, 2 specimens, March 20, 22; Llanos e Casco, Tepic-Jalisco boundary, 2 specimens, March 28; La Cienega, 2 specimens, April 15, 17; Las Canoas, 6 specimens, Aug 4, 5, 13, 22; Los Masos, 1 specimen.

External measurements: 5 males, total length, 409 (400–413); head and body, 372 (362–381); tail vertebræ, 37 (33–38); hind foot without claws, 84 (83–89); ear from notch, 63 (55–67); tip to tip of ears distended laterally, 181 (171–191): 6 females, total length, 422 (406–438); head and body, 385 (368–400); tail vertebræ, 37 (35–38); hind foot without claws, 84 (83–86); tip to tip of ears distended laterally, 188 (165–200).

Skulls: 4 males, occipito-nasal length, 73 (71–77); zygomatic breadth, 35 (34–37); parietal breadth (greatest width of braincase), 26 (25.3–27): 4 females, occipito-nasal length, 77 (76–80); zygomatic breadth, 36.5 (36–37); parietal breadth, 27 (25–27.5).

As is often the case in this genus, the females average slightly larger than the males. In the present case, however, the females average slightly older than the males, although all are fully adult.

Apparently this very distinct form of the *L. floridanus* group agrees satisfactorily with *L. f. subcinctus* Miller, described from "Nagrete, State of Michoacan," not far from the Jalisco boundary.

30. **Lepus callotis** *Wagler.*

Sixteen specimens: Arroyo de Gavalan, 8 specimens, Dec. 17, 18, 25; La Laja, 4 specimens, May 16, 29, and June 4; Las Canoas, 3 specimens, Aug. 18; Artenkiki, 1 specimen, Sept. 10.

Collector's measurements: 7 adult males, total length, 516 (508–530); head and body, 446 (425–457); tail vertebræ, 70 (64–76); hind foot without claws, 118 (114–124), with claws about 10 mm. more; ear from notch, 122 (118–129); spread of ears from tip to tip, directed laterally, 332 (321–349): 7 adult females, total length, 520 (514–537); head and body, 461 (438–490); tail vertebræ, 69 (64–76); hind foot without claws, 116 (108–124); spread of ears, 345 (326–365). Skulls: 4 males occipito-nasal length, 90 (85–93); zygomatic breadth, 43.4 (42.6-44): 3 females, occipito-nasal length, 91 (89-93).

31. **Felis oregonensis aztecus** *Merriam.*

One specimen, skin and skull of an old female, Los Masos.

32. **Felix glaucula** *Thomas.*

Two specimens, Los Masos.

33. **Canis vigilis** *Merriam.*

Three specimens, 1 male, 2 females, all adult: Ojo de Agua, Tepic, 1 specimen, Feb. 12; Las Canoas, Jalisco, 1 specimen, Aug. 17; Artenkiki, 1 .specimen, Sept. 13.

In size and coloration these specimens present the same characters as the series from Sinaloa (*antea*, p. 223). The external measurements are: Total length, 1144 (♂), 1118 (♀), 1099 (♀); head and body, 826, 826, 775; tail vertebræ, 318, 294, 324; hind foot without claws, 191, 178, 178; ear from notch, 114, 108, 108. Skulls, total length, 194 (♂), 190 (♀), 195 (♀); basal length, —, 167, 170; zygomatic breadth, 99, 99. 5, 98.5; mastoid breadth, 61, 62, 63.

34. **Urocyon cinereoargenteus scotti** *Mearns.*

Thirteen specimens: Rio Sta. Maria, 1 specimen, Feb. 4; Ojo de Agua, 1 specimen, Feb. 11; Estancia, 1 specimen, Feb. 22; Sal se Puerdes, 1 specimen, May 10; Volcan de Fuego, 1 specimen, July 13; Las Canoas, 5 specimens, Aug. 9, 16, 19, Sept. 2; Los Masos, 3 specimens.

This series consists, in the average, of much younger specimens than the Sinaloa series (see *antea*, p. 224), ranging from young adults to middle-age, with some so young that they have not fully acquired the mature dentition. The older specimens agree in size with specimens of corresponding age in the Sinaloa series, nor are they appreciably different in coloration.

35. **Bassariscus astutus astutus** (*Lichtenstein*).

Four specimens (3 adult, 1 immature): Rio Sta. Maria, Jalisco, Feb. 4; Arroyo de Plantanar, March 14; La Cienega, April 24; Los Masos.

In two of the adult specimens the ventral surface is pale buff. Measurements of 2 adults: Total length, 781, 838; head and body, 375, 381; tail vertebræ, 406, 457; hind foot without claws, 73, 73; ear from notch, 51, 52.

"Native name *Sal Coyote.* Inhabits the mountains of central and western Mexico, especially rocky localities, such as dry river bottoms, cañons, broken hills, and ridges. Nocturnal in habits, hunting cat-like for rodents and large insects. Fruit furnishes its main food in the wet season, especially wild figs and the coporno balls. It is a good climber and readily escapes from dogs when it is followed." — J. H. B.

36. **Procyon hernandezii hernandezii** *Wagler.*

Five specimens, 3 males, 1 female: Arroyo de Plantanar, Jalisco, 1 specimen, Feb. 19; Garabatos, 2 specimens, March 22, 26; Las Canoas, 2 specimens, Aug. 4, 9.

These specimens are all fully adult, with worn teeth. They average, on account of greater age, slightly larger than the Sinaloa series (see *antea*, p. 226), the skulls of the 3 males measuring, total length, 122.7 (119–125), zygomatic breadth, 77.5 (76–79). The collector's external measurements of the 3 males are: Total length, 852.5 (826–883); head and body, 541 (508–559); tail vertebræ, 311.5 (299–324); hind foot without claws, 118 (112–126); ear from notch, 64 (57–65). The female is slightly smaller than the smallest of the four males.

37. **Nasua narica narica** (*Linn.*).

Fifty-four specimens, collected as follows: Arroyo de Plantanar, 3 specimens, Jan. 22, Feb. 20, 22; Rio Sta. Maria, 4 specimens, Feb. 2, 3, 9; Ojo de Agua, near Amatlan, Tepic, 5 specimens, Feb. 12, 13, 15; Estancia, 11 specimens, Feb. 1, 22, March 3–11; La Cienega, 1 specimen, April 17; Wakenakili Mountains, 1 specimen, May 7; Sal se Puerdes, 8 specimens, May 7–11; Los Masos, 5 specimens. Also 17 specimens, without data other than the collector's numbers (his corresponding notes are not now available), but they are from the same localities as the others collected in northwestern Jalisco, and mostly from quite near the Tepic boundary.

This series of specimens is comparable as to season with the Escuinapa February–May series. They present the same wide range of individual variation in coloration (see *antea*, pp. 229–231), but are on the whole rather darker and richer in color, with a larger proportion of specimens with the head, nape, and shoulders deep ochraceous.[1] They also average considerably smaller in external measurements, and slightly smaller in cranial measurements, with very slightly smaller teeth, and a greater breadth of skull in comparison with the length. (Compare the table of cranial measurements with those of the Sinaloa series, *antea*, p. 234.)

---

[1] The Los Masos specimens, however, are all dark, with the top of the head, nape, and shoulders dark brown.

The present series is provisionally referred to true *narica* of eastern Mexico, rather than to *molaris*, which, if it really be a well-marked form, is apparently confined to the coast region of western Mexico, from the State of Colima northward. Lack of sufficient material from eastern Mexico for a proper study of the Mexican Coatis renders these determinations tentative.

The collector's measurements are: 3 old males, total length, 1095 (1057-1143); head and body, 549 (536–559); tail vertebræ, 546 (521–584); hind foot without claws, 93 (89–95), with claws about 10 mm. more; ear from notch, 40 (38–44): 4 old females with worn teeth, total length, 1047 (985–1105); head and body, 516 (483–532); tail vertebræ, 541 (502–584); hind foot, 83 (80–89); ear, 40 (37–43): 6 adult females, with the teeth not worn, total length, 1013 (978–1092); head and body, 512 (483–584); tail vertebræ, 501 (470–546); hind foot, 88 (80–98); ear, 40 (38-44).

The cranial measurements of these same specimens, with others (of which the external measurements are not available), are given in the subjoined table. They show the same variation with age and sex as the Sinaloa series (*cf. antea*, p. 233), the measurements being divided into three categories according to the sex and age of the specimens. These measurements may be summarized as follows:

Old males, with sagittal crests but the teeth showing practically no wear (hence a little younger than the Sinaloa series of 'old males'): 8 specimens, total length, 133 (129–137); basal length, 115.5 (112–120); palatal length, 80 (78–82); postpalatal length, 35.8 (33–38); zygomatic breadth, 73.3 (70–78.5); interorbital breadth, 27.6 (28–34); postorbital breadth, 28 (23–33); mastoid breadth, 47.8 (44–51.5); audital bulla, 10.6 × 12.9 (10 × 11–12 × 14.5); pm^4-m^2, 21.6 (21–22.7); height of occipital crest, 0–9.

Old females (teeth worn): 7 specimens, total length, 127.5 (122–130); basal length, 110 (107–113); palatal length, 76.4 (73.5–79); postpalatal length, 34 (33–35); zygomatic breadth, 63.4 (60–65); interorbital breadth, 29.3 (27–31); postorbital breadth, 32 (30–33); mastoid breadth, 45.2 (43–47); audital bulla, 10.3 × 13.5 (10 × 12 or 9.5 × 13–11.5 × 15); pm^4-m^2, 21.3 (20.6–22.7).

Adult females (teeth wholly unworn): 9 specimens, total length, 125 (123–127); basal length, 109.7 (107–112); palatal length, 76.4 (74–78.5); postpalatal length, 33.3 (32–34); zygomatic breadth, 61.2

MEASUREMENTS OF 24 SKULLS OF *Nasua narica molaris*, FROM STATE OF JALISCO.

Mus. No.	Sex	Total length	Basal length	Palatal length	Postpalatal length	Zygomatic breadth	Interorb. breadth	Postorb. breadth	Mastoid breadth	Audital bullæ	Length of pm^4–m^2	Height of crest	Condition of teeth
25200	♂	134.5	119	81	38	—	32	23	51.5	11 x 13	21	9	Worn.
25191	♂	129	113	80	33	71.5	28	25.5	47	10.5 x 11.5	21.4	5	Not worn.
25248	♂	133.5	115	80	35	74	30.5	27	47.5	11 x 13.3	22.7	5.5	“ “
25254	♂	134.5	115	78	37	78.5	33	29	48	10 x 15	21.3	7	“ “
25844	♂	129	112	78	35	72	28	27	47.5	10 x 11.5	22	2	“ “
25215	♂	131.5	114	79	35	70	34	33	47	10 x 11	21	4	“ “
25204	♂	137	120	82	37	72.5	29	30	50	12 x 14.5	22	5	“ “
25545	♂	133	115	80	36	74.3	26.5	30.5	44	10 x 13	22.4	0	“ “
Average, 8 old	♂ ♂	133	115.5	80	35.8	73.3	27.6	28	47.8	10.6 x 12.9	21.6		
25213	♀	130	113	78	35	64	28	30	47	11.5 x 15	22.7	0	Not worn.
25247	♀	130.5	113	79	34	64.5	31	32	46.3	10 x 14.2	22	0	Slightly worn.
25841	♀	125.5	109	76	33	62	28	—	44.5	10 x 14	20.6	0	Worn.
25193	♀	122	107	73.5	33.5	64	27	32.5	44.5	9.5 x 13	21.3	0	“
25664	♀	129	109	75	34	64	30	32.5	43	10 x 12.5	20.7	0	Much worn.
25206	♀	126	109	—	—	65	30	32	46	10 x 12	21.5	0	“ “
25208	♀	129.5	111	76	35	60	30.5	33	45	11 x 14	21	0	Worn.
Average, 7 old	♀ ♀	127.5	110	76.4	34	63.4	29.3	32	45.2	10.3 x 13.5	21.3		
25207	♀	123.5	109	75	34	62	27	29	42.5	11 x 13	19.6	0	Not worn.
25199	♀	125	111	77.5	33.5	58.2	27	34	44	11.5 x 14	21	0	“ “
25244	♀	127	110	78	32	62	29	32.5	44	11.5 x 13.5	21.2	0	“ “
25205	♀	126.5	112	78.5	33.5	63	29	31.5	47	10 x 13	22	0	“ “
25192	♀	123	108	75	33	60	26.5	27	43.5	11 x 14	22	0	“ “
25194	♀	127	110	76	34	63.7	29	34	45	10.5 x 12	22	0	“ “
25245	♀	124	108	75	33	58	26	32	43	12 x 14.5	21	0	“ “
25212	♀	123	107	74	33	60.5	26	30.5	44	10 x 12.5	22	0	“ “
25249	♀	126.5	112	78	34	63.5	29	31.5	46	10 x 13	22	0	“ “
Average, 9 ad.	♀ ♀	125	109.7	76.4	33.3	61.2	27.6	31.2	44.4	10.8 x 13.3	21.4		

(58–63.5); interorbital breadth, 27.6 (26–29); postorbital breadth, 31.2 (27–34); mastoid breadth, 44.4 (42.5–47); audital bulla, 10.8 × 13.3 (10 × 12.5–11.5 × 14 and 12 × 14.5); pm^4-m^2, 21.4 (19.6–22).

38. **Mephitis macroura macroura** *Lichtenstein.*

Twenty-three specimens: Arroyo de Gavalan, 1 specimen, Dec. 19; Arroyo de Plantanar, 1 specimen, Feb. 19; Estancia, 4 specimens, Feb. 24, March 13; Rio Ameca, 1 specimen, March 18; Garabatos, 1 specimen, March 23; Llano e Casco, 2 specimens, March 28, 29; La Cienega, 1 specimen, April 23; La Laja, 5 specimens, May 16–19; Las Canoas, 2 specimens, Aug. 15, 23; La Joya, 1 specimen, Sept. 21; Artenkiki, 2 specimens (nurslings), Sept. 16; Los Masos, 2 specimens.

Collector's measurements: 7 adult males, total length, 658 (578-666); head and body, 291 (279–317); tail vertebræ, 367 (317–387); hind foot without claws, 58 (57–60); ear from notch, 30 (25–35): 10 adult females, 598 (540–654); head and body, 277 (261–305); tail vertebræ, 335 (305–362); hind foot without claws, 54 (51–56); ear from notch, 28 (25–33).

Skulls: Adult male skulls measure, total length, 70; basal length, 57; zygomatic breadth, 42; mastoid breadth, 35: adult female skulls, 67, 55, 39, 32.5.

This series presents the usual wide range of variation in color characteristic of the species. One specimen is almost wholly black, the only white being a few white hairs on the right side near the shoulder, a very narrow white line on the left side behind the shoulder, and a little white at the extreme base of the tail hairs. Even the white line so constantly present on the head is lacking in this specimen, and also in one other of the series. In the other extreme the dorsal surface and the tail are more than half white. In two young examples (nurslings), said by the collector to be both from the same litter, one is all black except for the usual narrow white head stripe, and a narrow lateral white band on each side, running from the ear to the base of the tail, widening on the thighs, and continued on the basal three-fourths of the *lower* surface of the tail. The other has the whole of the dorsal area, from the crown to the rump, white — an outer band of clear white enclosing a central area of mixed black and white (giving the effect of black veiled with white) — the whole *upper* surface of the tail white, and a broad lateral line of white on each side, from the ear to the posterior border of the thigh.

39. **Conepatus sonoriensis** *Merriam.*

Thirty-six specimens: Arroyo de Plantanar, 3 specimens, Feb. 16, 17; Estancia, 4 specimens, Jan. 22, 27, March 13; Garabatos, 6 specimens, March 20–26; La Laja, 13 specimens, May 17–24; Las Canoas, 9 specimens, Aug. 5, 12; Los Masos, 1 specimen.

Very uniform in coloration. The black at the base of the under surface of the tail, however, is somewhat variable, being usually limited to the basal inch or less (occasionally wanting), but sometimes extending to two inches or slightly more than two inches. Besides this, the sides and lower surface of the basal fourth to basal third of the tail have often a slight mixture of black hairs mingled with the white, sometimes amounting to a conspicuous blackish grizzle.

Collector's measurements: 16 males, total length, 616.3 (566–699 — only 2 above 631); head and body, 372.5 (337–445 — only 2 above 381); tail vertebræ, 238.8 (216–267 — only 1 above 257); hind foot without claws, 66 (60–70), with claws about 5–7 mm. more; ear from notch, 26 (25–28): 10 females, total length, 594 (551–635 — only 2 above 616); head and body, 349 (330–381); tail vertebræ, 245 (221–263); hind foot without claws, 63 (57–66); ear from notch, 25 (23–28).

Skulls: 8 skulls of males (fully adult to old) measure, total length, 80.6 (77.5–85); basal length, 66 (62–68.5); zygomatic breadth, 50 (45–56); mastoid breadth, 42.3 (41–45.5): an old female skull, 76, 62, 47.5, 38.

Compared with the Sinaloa series (*antea*, p. 225), the only difference in coloration is evidently mainly seasonal; the Sinaloa (Escuinapa) specimens were nearly all taken in February, just before the spring moult, and were thus in worn, faded pelage, and, excepting some of the younger specimens, were brownish black instead of deep black; the Jalisco series was all taken later in the season, mostly in May and August, when the pelage was unworn and fresh, with the black parts of the animal deep, intense black.

There is also no appreciable difference between the skulls of the two series, either in size or details of structure, a series of comparable male skulls varying in their principal measurements, in the average, less than a millimeter in length and about 2 mm. in breadth, the Jalisco specimens averaging slightly broader in both mastoid and zygomatic dimensions. There is, however, a notable discrepancy in external measurements, the Sinaloa series averaging about 100 mm. longer in total length, and about 25 mm. in length of tail vertebræ, with the length of hind foot and ear correspondingly greater. As the measurements were all taken by the same person the apparent difference in external measurements is probably a valid difference. As the two regions differ somewhat in comparative aridity, the intensity of the black in the Jalisco series as compared with the Sinaloa series may be only in part due to the season of capture.

Two old males and one female in the Sinaloa series and two old males of the Jalisco series greatly exceed in size any other specimens of either series, the total length of the former being respectively 738 and 769 (♂) and 699 (♀), and of the latter 699, 699, — about 130 and 86 mm. above the next in size. They are apparently simply giants of their race. The skulls of these specimens, while the largest of the series, do not, however, so greatly exceed the next in size.

None of the specimens of the Jalisco series seem referable to *Conepatus mesoleucus mearnsi*, which is supposed to range over the Jalisco tableland.

It is worthy of note that one of the skulls of this series (No. 25170, ♀ ad., Arroyo de Plantanar, Feb. 16, 1905) has three supernumerary premolars in the upper jaw, one on the left side, in size and form resembling the anterior upper premolar in *Mephitis*, and two on the right, much smaller, but the two equalling in bulk the single supernumerary premolar on the left side. The larger of these two is anterior in position to the other.

40. **Spilogale angustifrons angustifrons** *Howell.*

Eleven specimens: Arroyo de Plantanar, 1 specimen, Feb. 17; Garabatos, 4 specimens, March 24–29; Estancia, 5 specimens, Jan. 27, Feb. 22, March 8, 11, 17; Rio Ameca, 1 specimen March 20.

Collector's measurements: 5 males, total length, 378 (352–390); head and body, 236 (222–248); tail vertebræ, 142 (130–152); hind foot without claws, 38 (35–41), with claws, 44; ear from notch, 25.6 (22–29): 6 females, 346 (336–374); 221 (216–241); 125 (114–133); 35 (33–38); 23 (22–25).

One of the females (the skin shows it to have been correctly marked for sex) exceeds in size the average of the males, and one of the males barely exceeds the average for the females.

Some of the specimens have a broad white band across the thighs, while others are entirely without it; in still others the band is reduced to a small spot or even to a few white hairs.

41. **Putorius frenatus frenatus** (*Lichtenstein*).

Two specimens, Artenkiki, Sept. 5, and Los Masos.

42. **Sorex oreopolus** *Merriam.*

One specimen, in faded, worn pelage, Volcan de Fuego, altitude 13,000 feet, Sept. 12.

43. **Myotis velifer** (*J. A. Allen*).

Nineteen specimens: Las Canoas, 17 specimens (10 salted), Sept. 1–4; Artenkiki (near Las Canoas), 2 specimens, Sept. 5.

Collector's measurements of 9 specimens: Alar expanse, 295 (289–305); length, 56 (51–63).

44. **Myotis thysanodes** *Miller.*

Seven specimens, Los Masos.

45. **Myotis californicus mexicanus** (*Saussure*).

Three specimens, Los Masos.

46. **Myotis nigricans** (*Wied*).

Eight specimens, Los Masos.

47. **Vespertilio fuscus** *Beauvois.*

Five specimens, Los Masos. Forearm, 47–49 mm.

48. **Lasiurus borealis mexicanus** (*Saussure*).

Five specimens, Los Masos. Forearm, 38–40 mm.

49. **Lasiurus cinereus** (*Beauvois*).

One specimen, Los Masos.

50. **Molossus nigricans** *Miller.*

One specimen, Los Masos.

51. **Molossus obscurus** *Geoffroy.*

Two specimens, Los Masos. Forearm, 39 mm.

52. **Nyctinomus mexicanus** *Saussure.*

Thirty specimens: 16 skins and skulls, and 14 salted specimens, Las Canoas, Sept. 1–5.

53. **Spectrellum mexicanum** (*Miller*).

Twelve specimens, Rancho Palo Amarillo, near Amatlan, Tepic, Jan. 15, 16.

These specimens range in color from pale buffy brown to ochraceous. Alar expanse, 254–279, averaging about 267; length (body only), 35–45.

54. **Chilonycteris mexicana** *Miller.*

Fourteen specimens, Rancho Palo Amarillo, 13 specimens near Amatlan, Jan. 16, 19, 20, Feb. 9; Los Masos, 1 specimen. All but two are in the dark phase; the others are more yellowish on the head and shoulders, but only slightly approach the yellow phase, described as "entire head and body tawny ochraceous."

Collector's measurements of 5 specimens: Alar expanse, 368 (337–375); length, 61 (60–63).

55. **Pteronotus davyi fulvus** (*Thomas*).

Three specimens, Los Masos. In one the pelage is bright fulvous, in the others dark brown.

56. **Aello megalophylla senicula** (*Rehn*).

Two hundred and sixty-four specimens: Rancho Palo Amarillo, near Amatlan, Tepic, 56 specimens, skins and skulls, and 195 salted specimens, Jan. 16–20; Ojo de Agua, 4 specimens, skins and skulls, Feb. 9; Los Masos 9 specimens, skins and skulls.

The series includes about an equal number of males and females. There is apparently no sexual difference in either size or coloration. The species is slightly dimorphic, with a yellowish brown phase and a darker, somewhat dusky brown phase. According to the collector's measurements the alar expanse averages about 368 mm. (352–381), with very few specimens below 362 or above 374; the length averages about 64, ranging from 60 to 70.

57. **Glossophaga mutica** *Merriam.*

Six specimens, skins and skulls, and 70 salted specimens, Rancho Palo Amarillo, near Amatlan, Jan. 16, 19.

58. **Chœronycteris mexicana** *Tschudi.*

Eighteen specimens, Los Masos. All are dark brown except one, which is deep fulvous, showing that the species is dichroic.

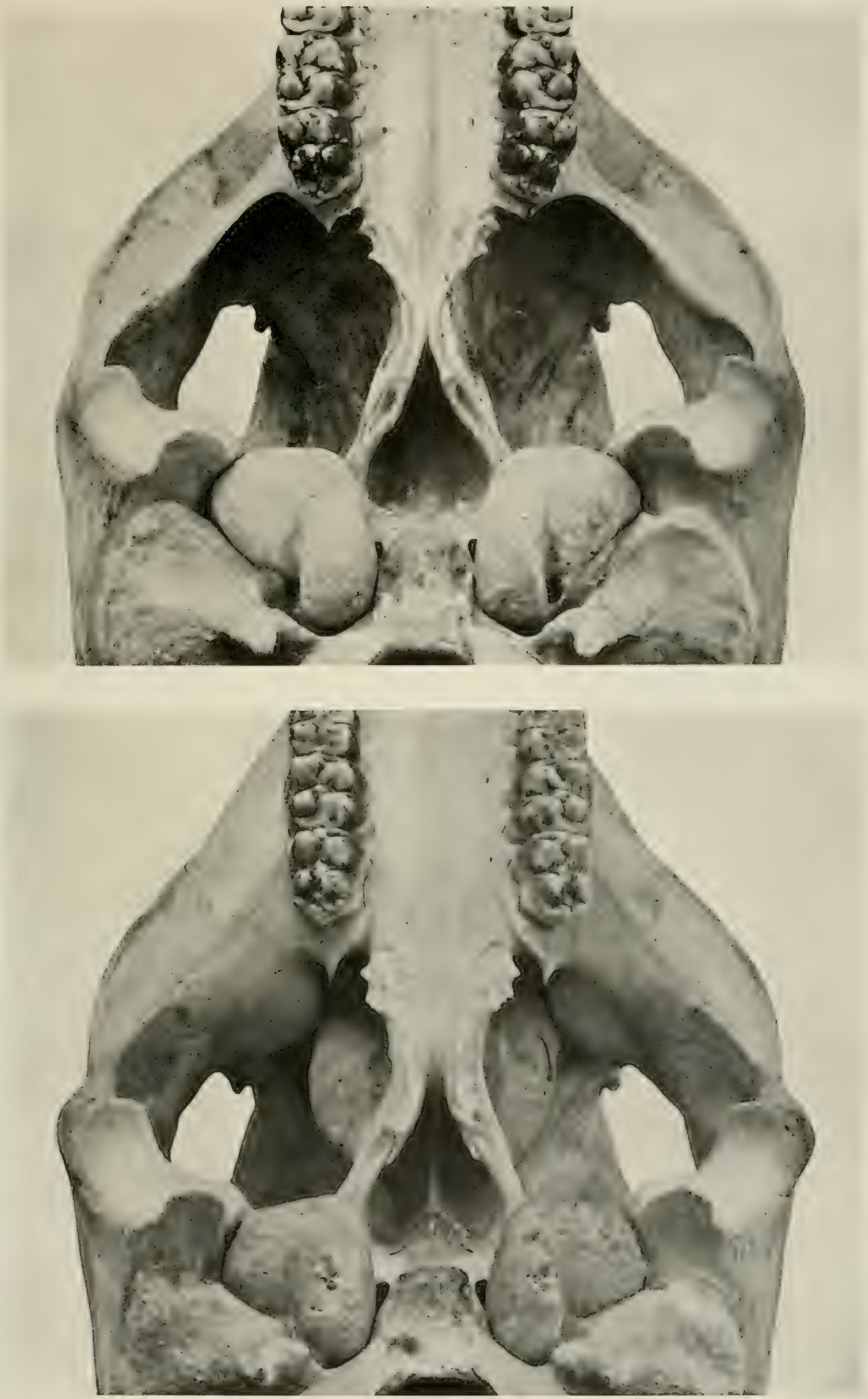
59. **Dermanura tolteca** (*Saussure*).

Four specimens: Artenkiki, 2 specimens, near Las Canoas, Sept. 16, Los Masos, 2 specimens.

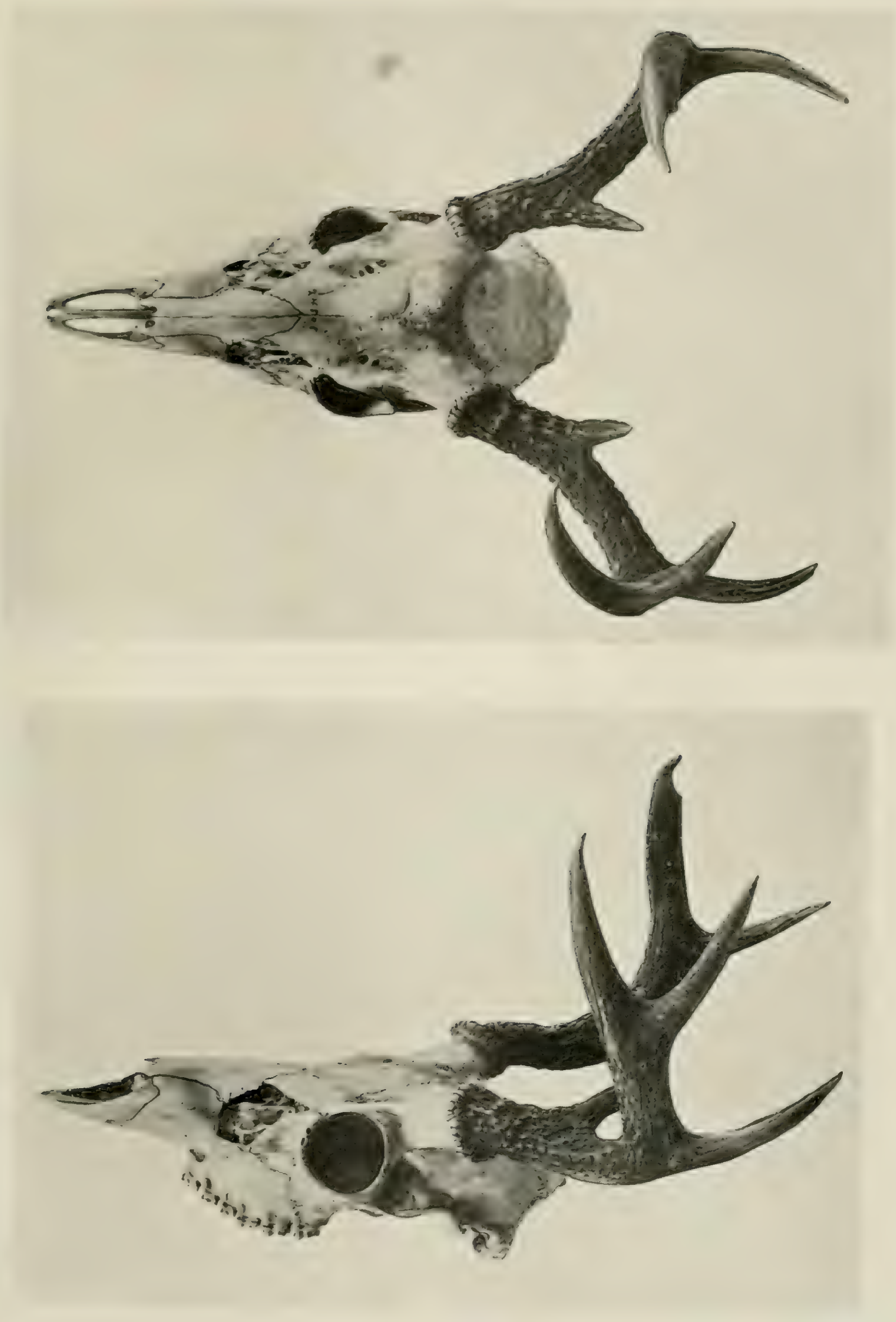
60. **Desmodus rotundus** (*E. Geoffroy*).

Seven specimens: Rancho Palo Amarillo, near Amatlan, Tepic, 2 specimens, Jan. 15, 19; Las Canoas, Jalisco, 5 specimens, Aug. 27, 28.

The specimens are all in the dark phase, — blackish with the extreme tips of the hairs light. The 5 Las Canoas specimens, all males, measure: Alar expanse, 386 (375–400); length, 84 (82–85).

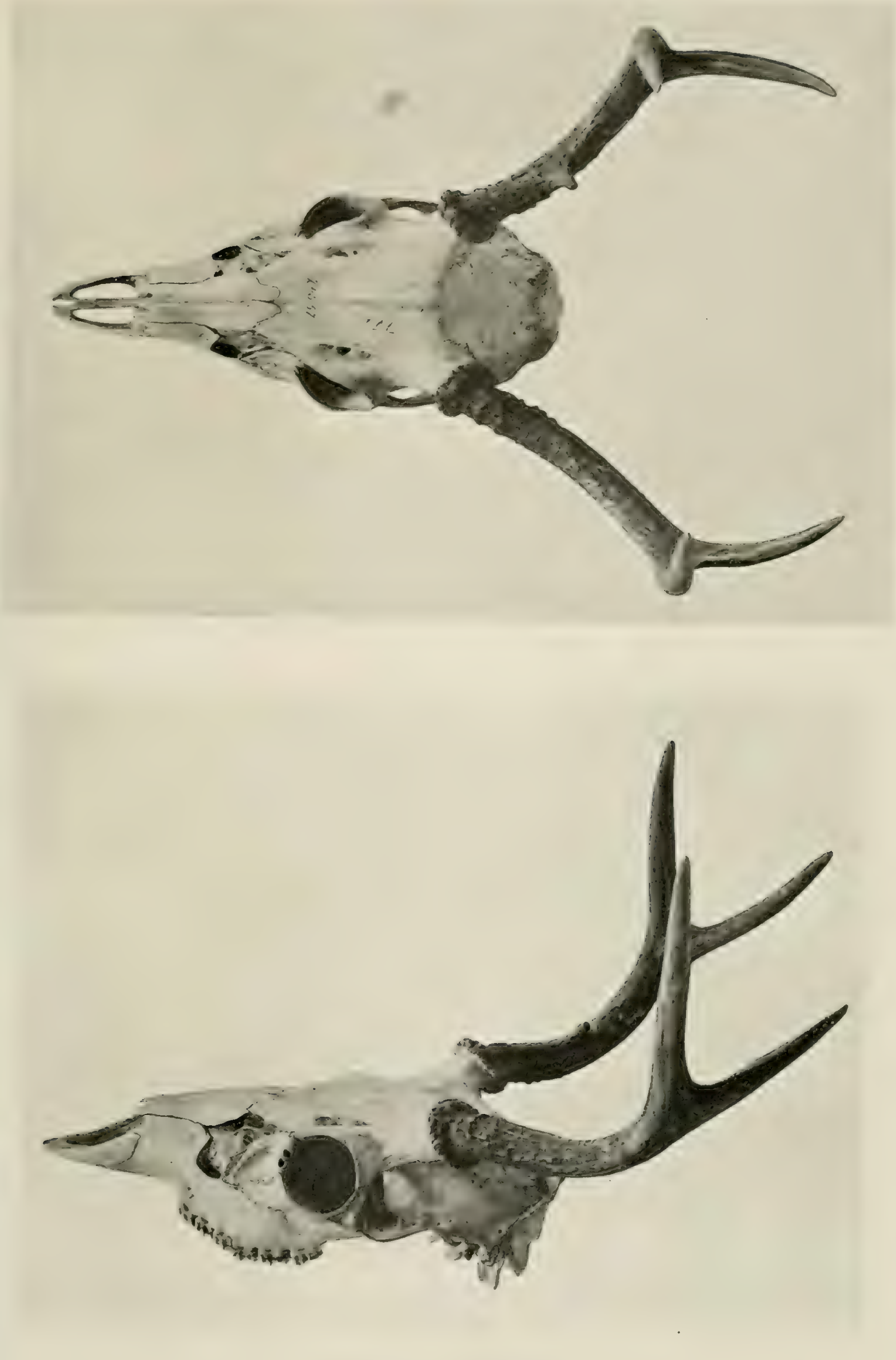


TAYASSU ANGULATUM SONORIENSE.



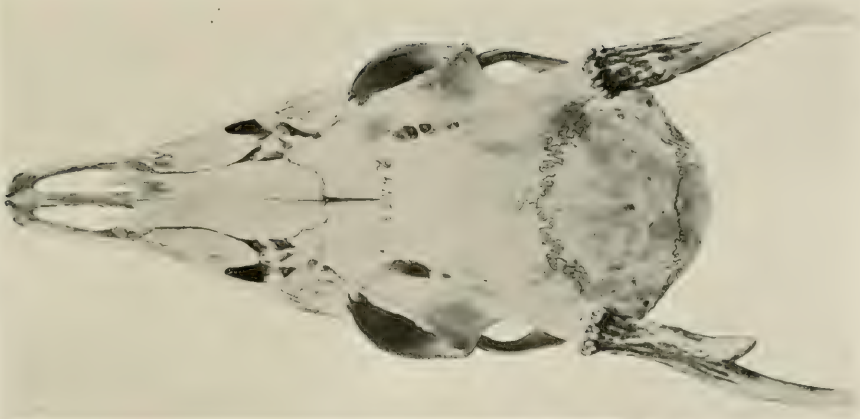
ODOCOILEUS SINALOAE.

Old male, No. 24808, Escuinapa, Sinaloa, Mex.
About one-third natural size. Teeth somewhat worn; animal probably six years old.

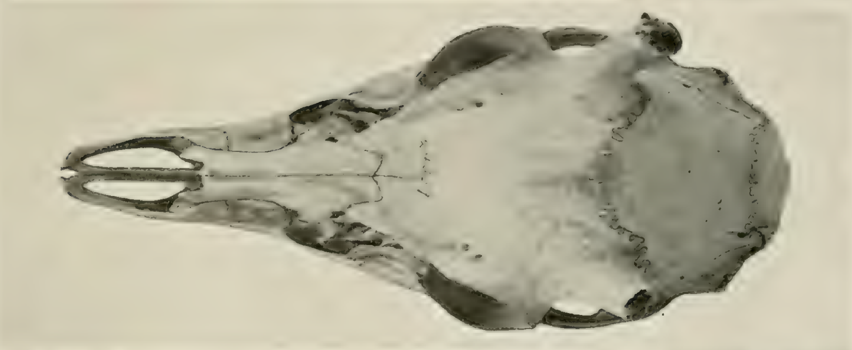


ODOCOILEUS SINALOAE.

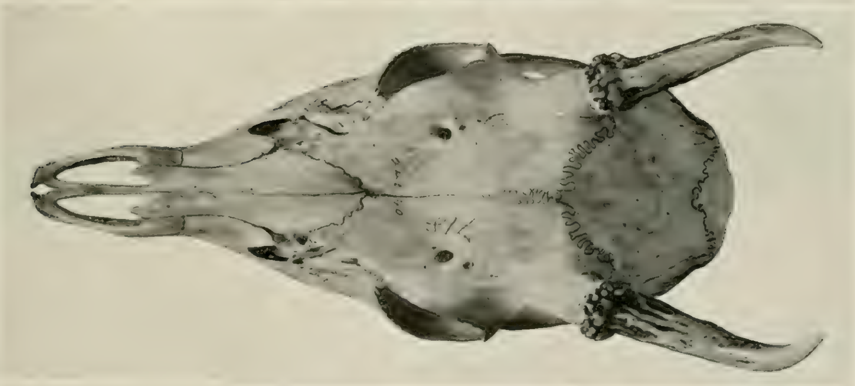
Young adult male, No. 24557, Escuinapa, Sinaloa, Mex.
About one-third natural size Teeth slightly worn; animal probably four years old.



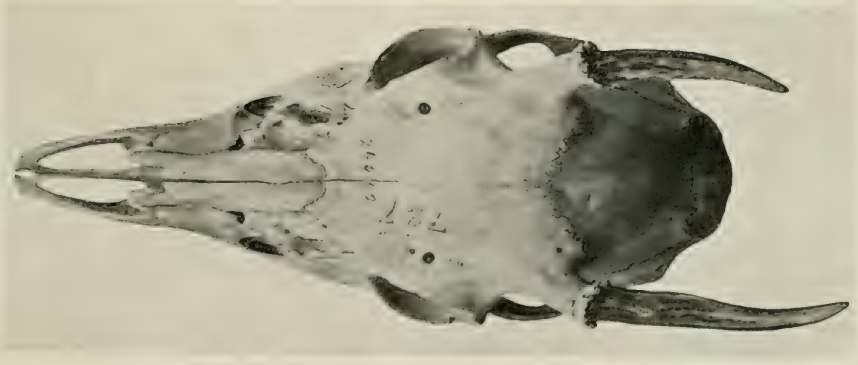
1.



2.

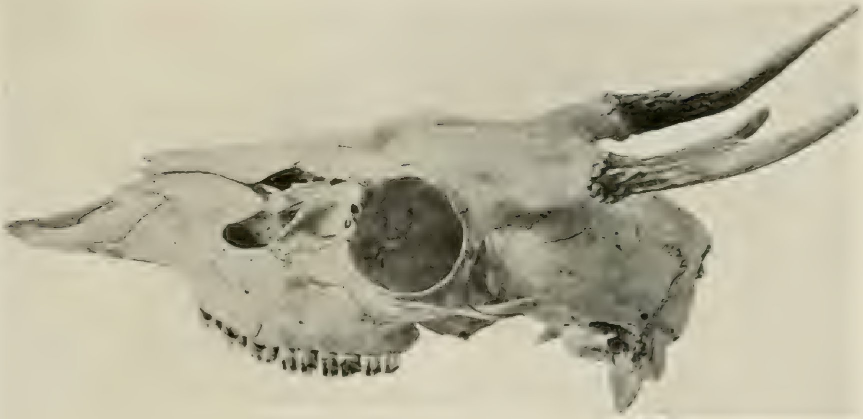


3.

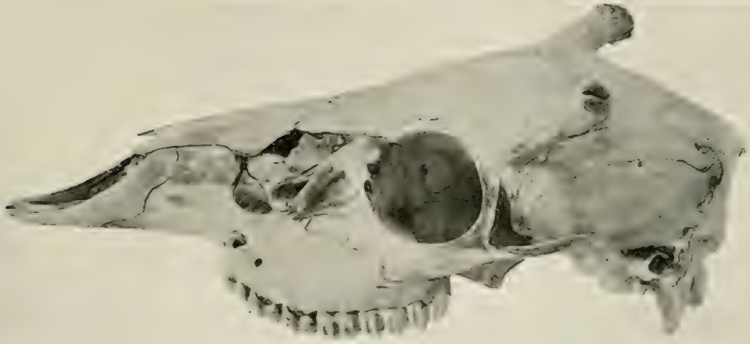


4.

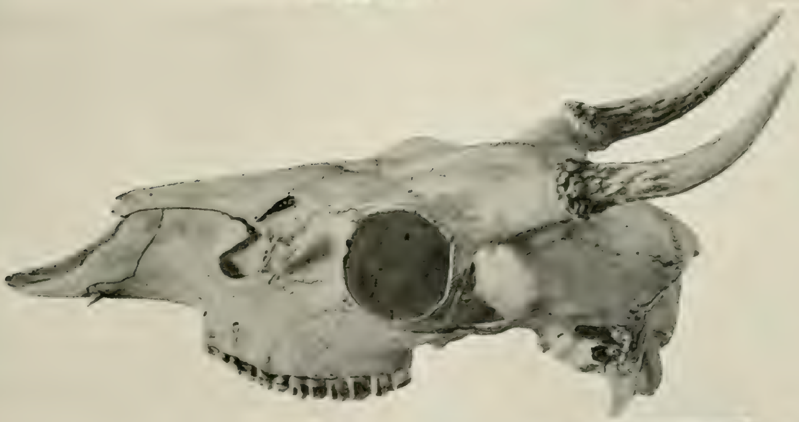
ODOCOILEUS SINALOAE.



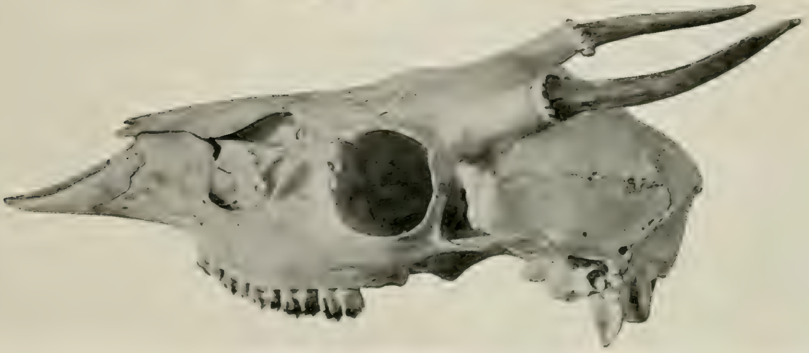
1a.



2a.

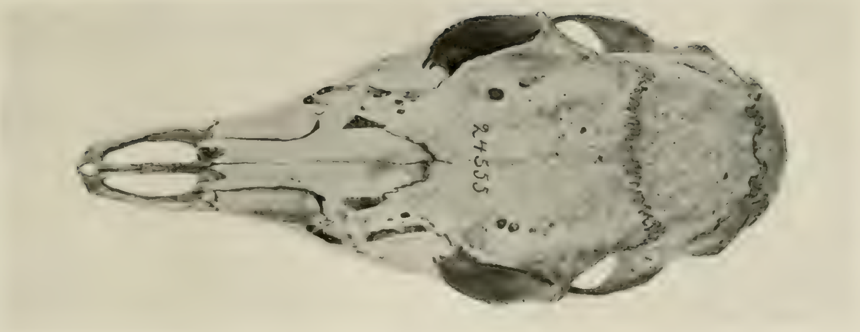


3a.

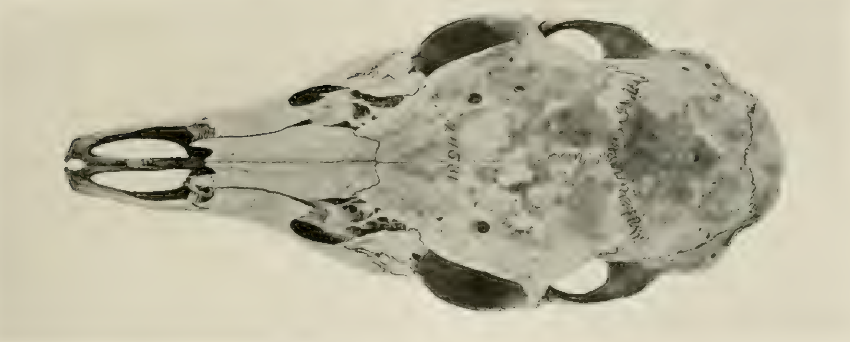


4a.

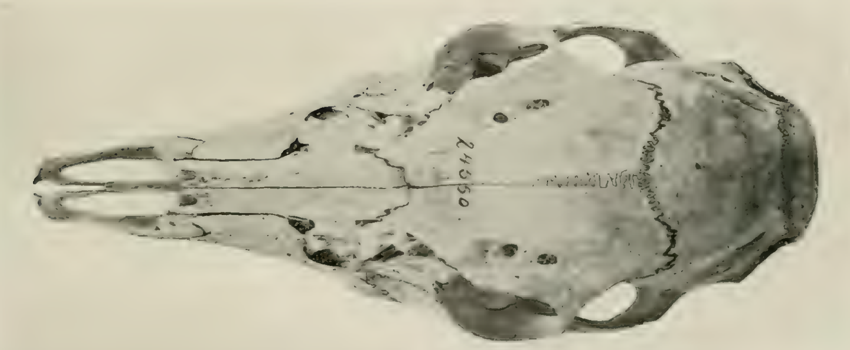
ODOCOILEUS SINALOAE.



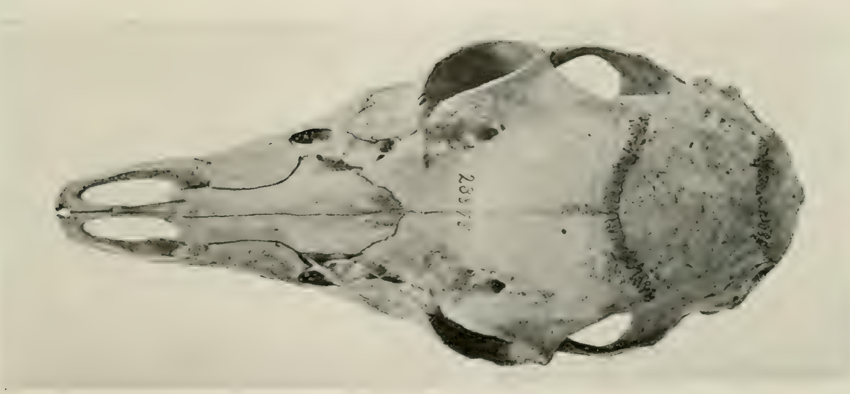
5.



6.

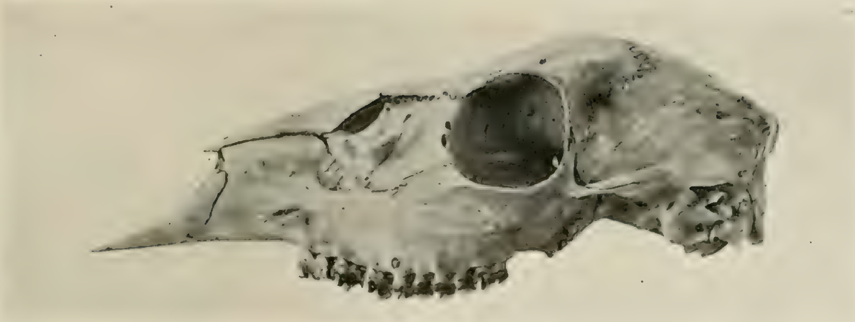


7.

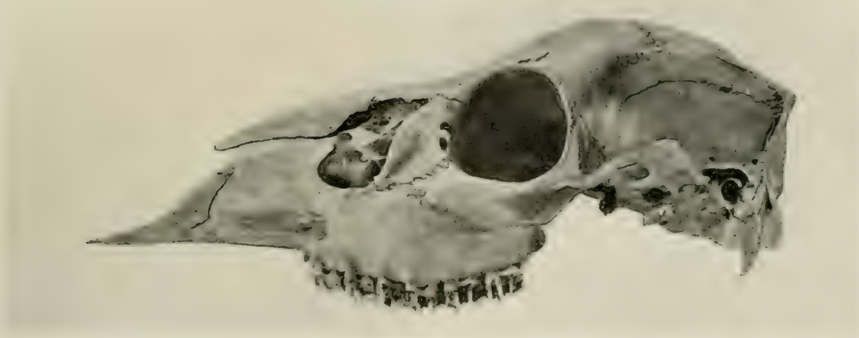


8.

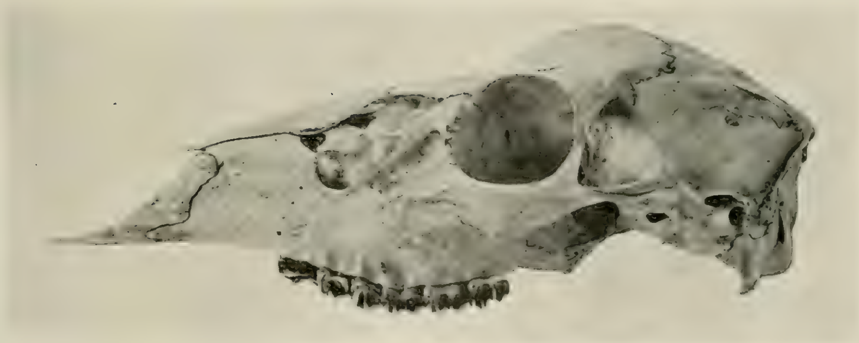
ODOCOILEUS SINALOAE.



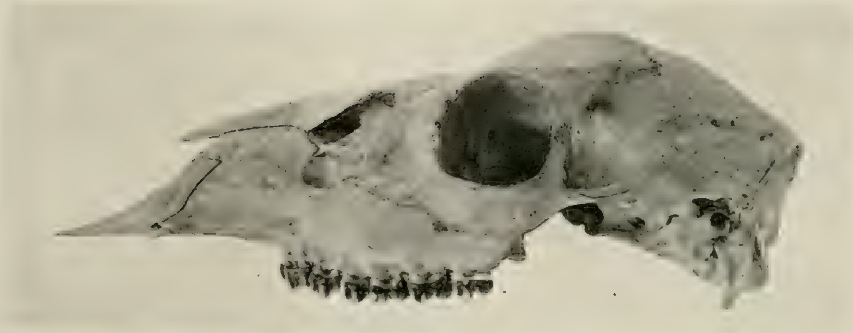
5a.



6a.

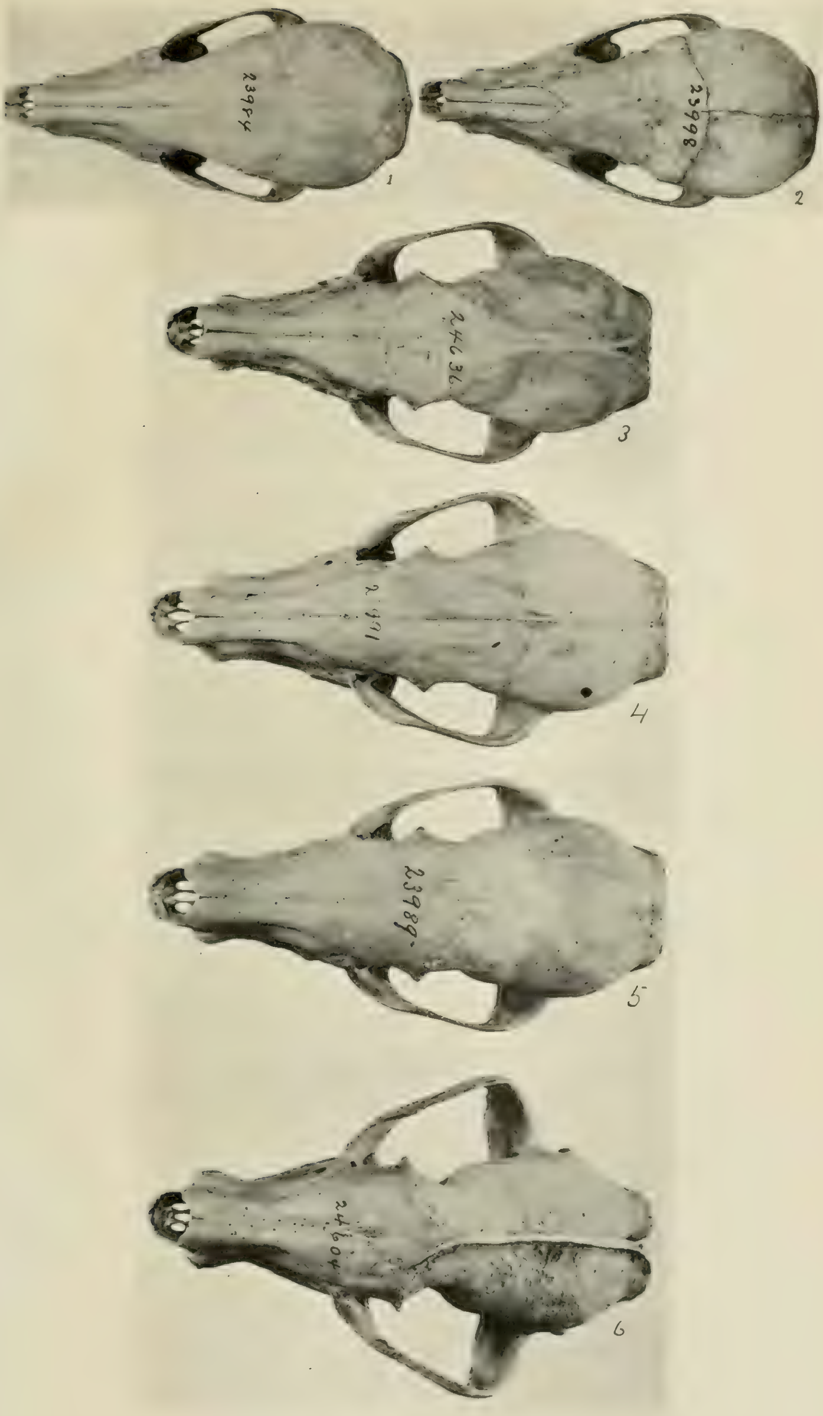


7a.

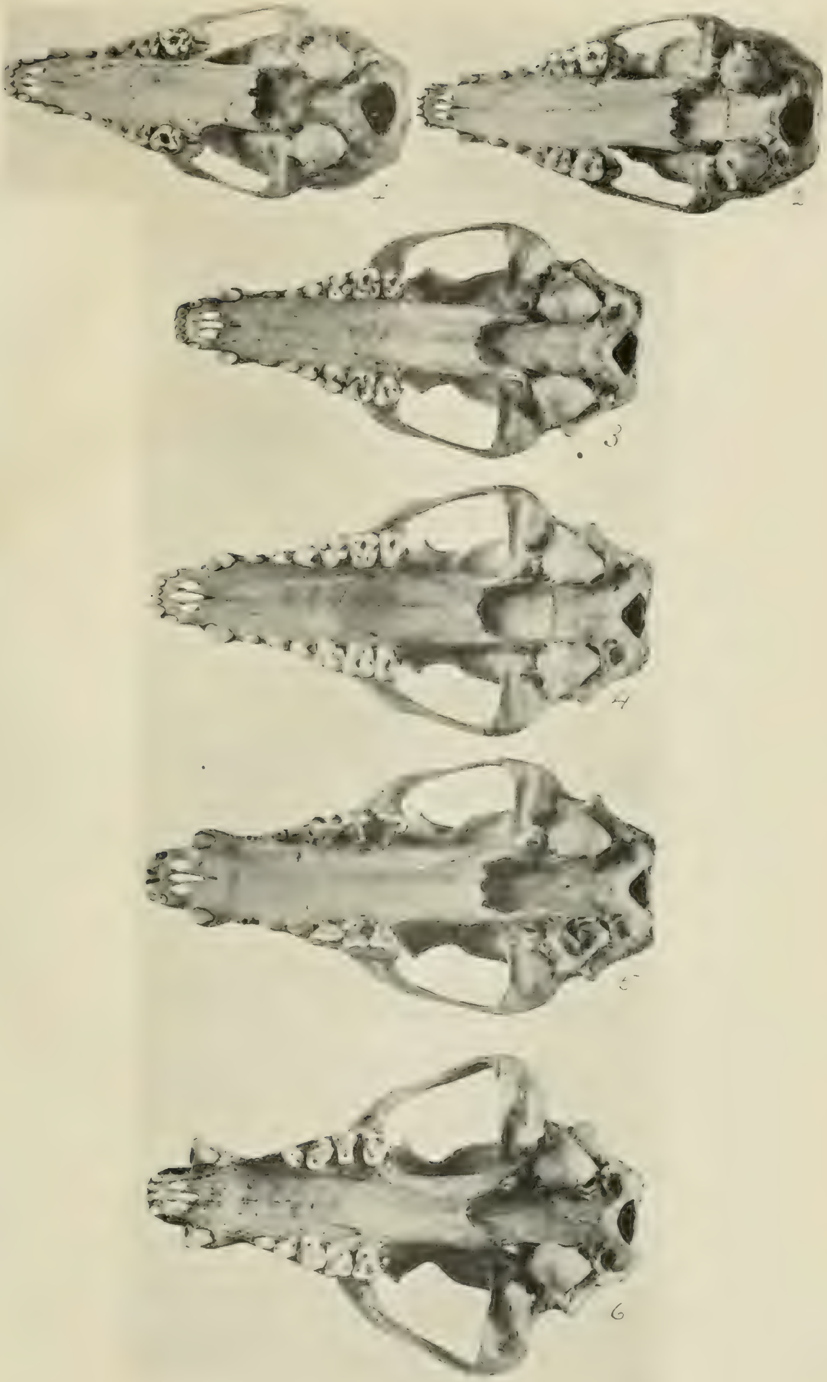


8a.

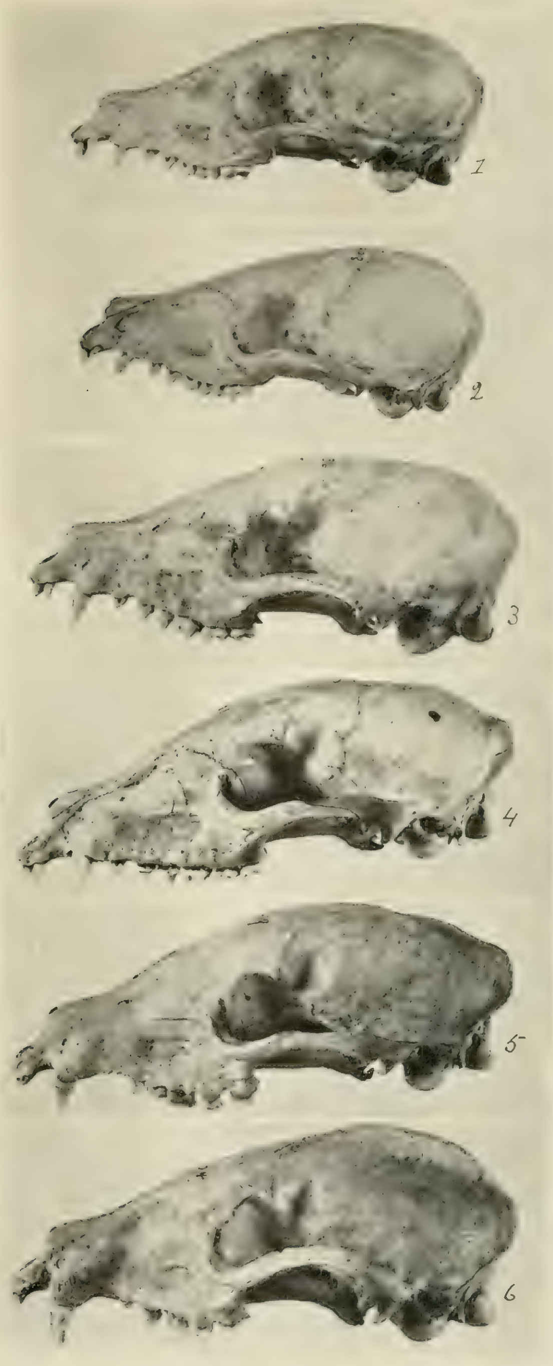
ODOCOILEUS SINALOAE.


23984
1
23998
2
24636
3
4
23989
5
24604
6

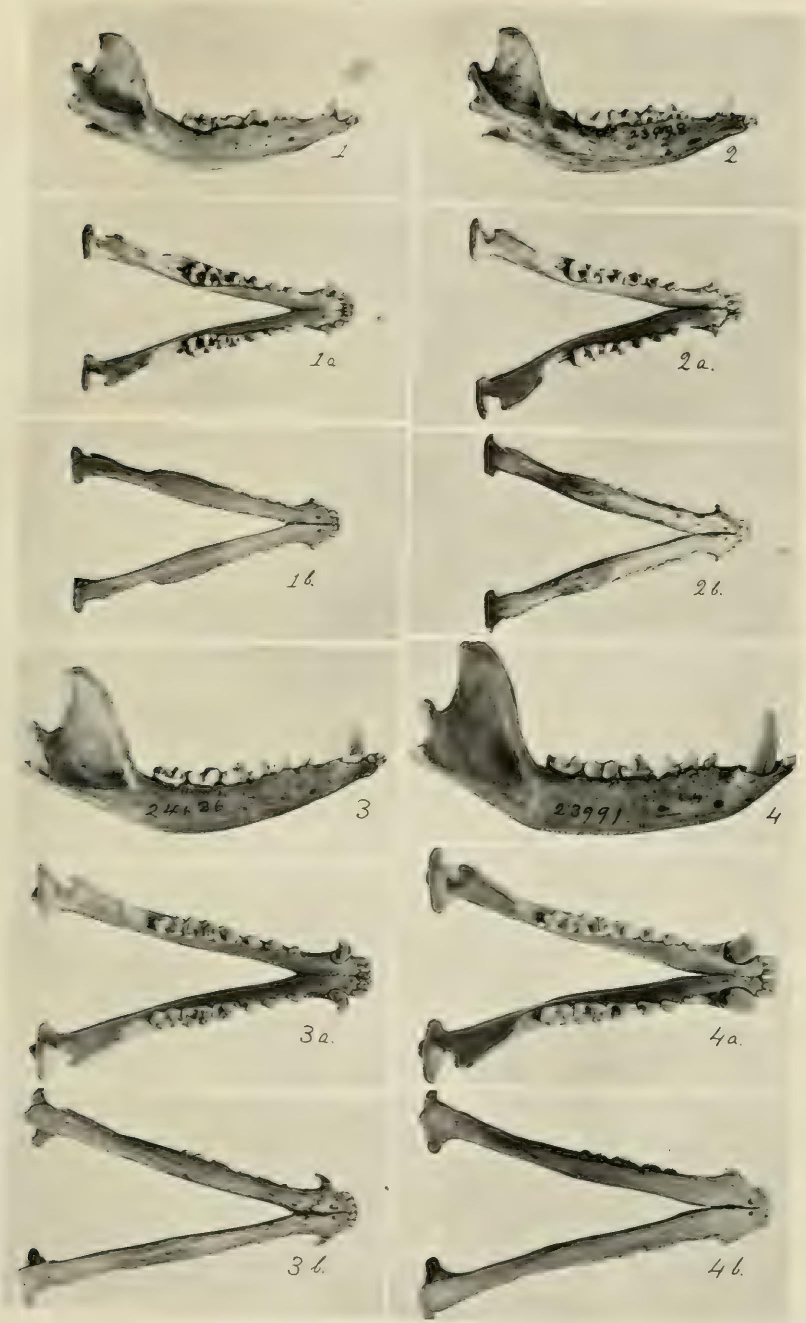
NASUA NARICA MOLARIS.



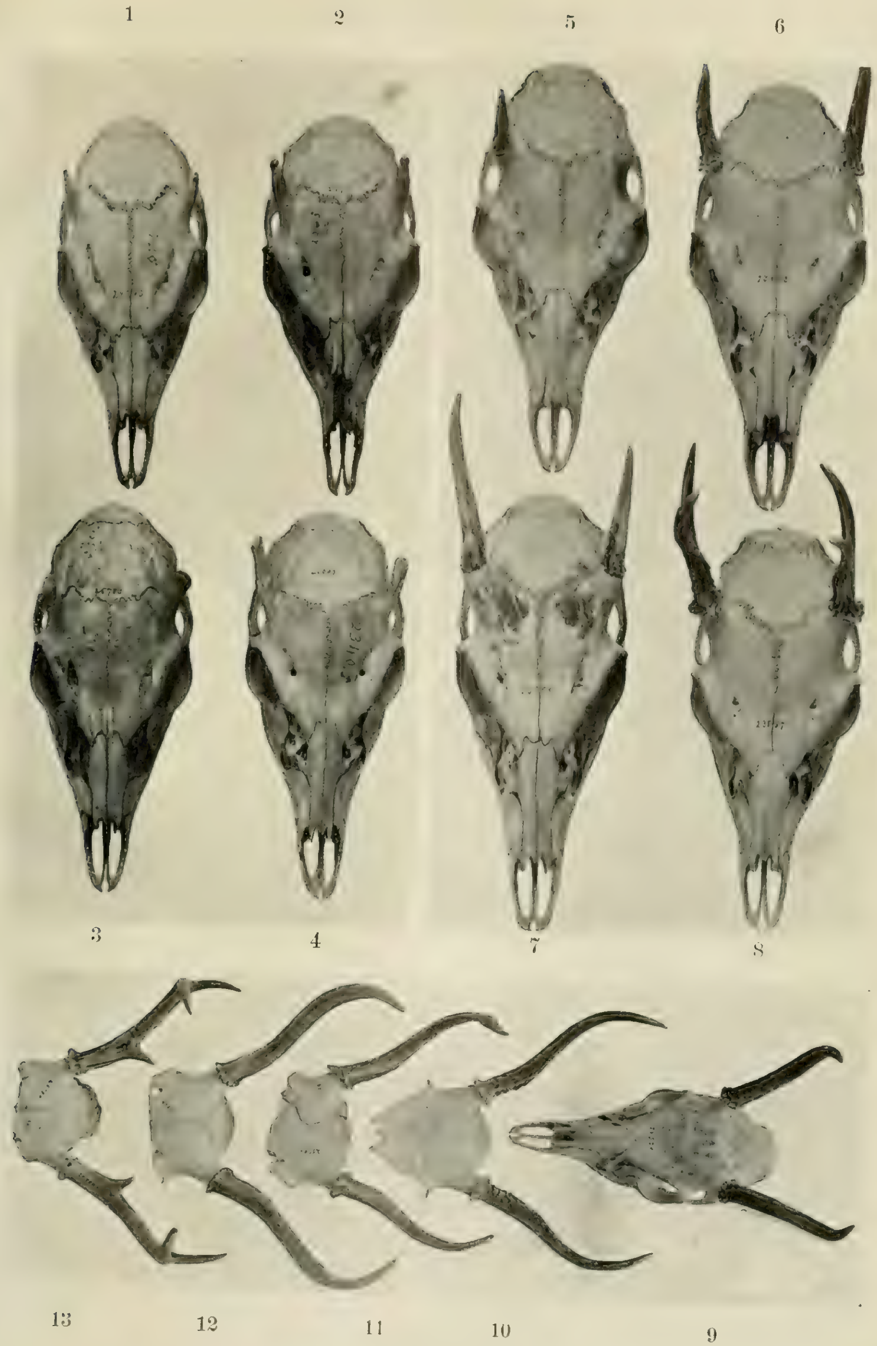
NASUA NARICA MOLARIS.



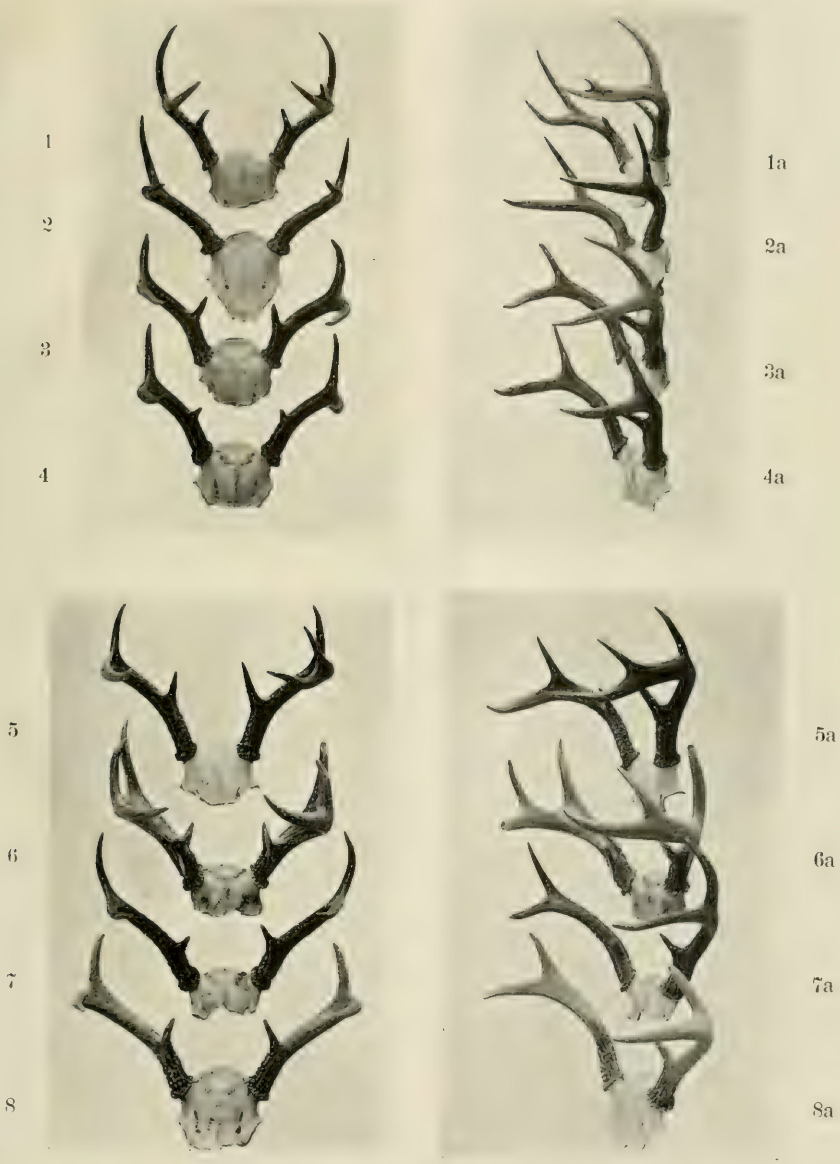
Nasua narica molaris.


1
23998
2
1a
2a.
1b.
2b.
24136
3
23991
4
3a.
4a.
3b.
4b.

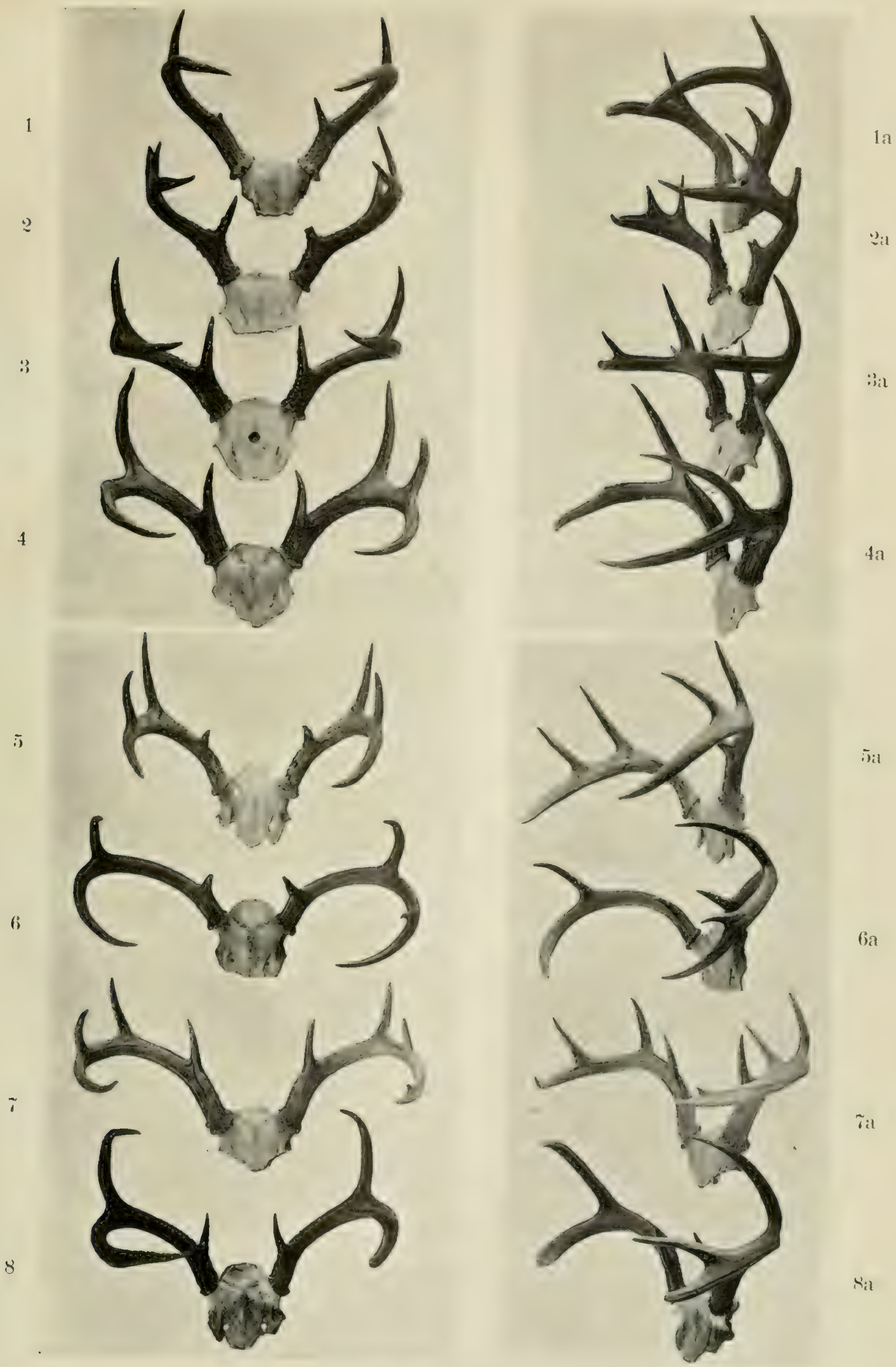
NASUA NARICA MOLARIS.


1
2
5
6
3
4
7
8
13
12
11
10
9

ODOCOILEUS SINALOÆ.


1
2
3
4
1a
2a
3a
4a
5
6
7
8
5a
6a
7a
8a

ODOCOILEUS SINALOÆ.


1
2
3
4
5
6
7
8
1a
2a
3a
4a
5a
6a
7a
8a

Odocoileus sinaloæ.

56.9,62S:14.31,4(1181:62)

Article XIII.—MILK DENTITION OF THE HYRACOID SAGHATHERIUM FROM THE UPPER EOCENE OF EGYPT.

By Henry Fairfield Osborn.

I am indebted to my friend Professor Eberhard Fraas for a second opportunity to describe a fossil Hyracoid. The first was that afforded by the description of *Pliohyrax* from the Lower Pliocene of Samos. The present is that afforded by the kind transmission of a specimen from the Upper Eocene of the Fayûm, No. 11579, "Coll. Markgr. 1905," Stuttgart Museum.

The specimen consists of the anterior portion of the skull, which appears to correspond closely with *Saghatherium antiquum* of Andrews and Beadnell. Unlike the type of that species, which contains the adult dentition, the present specimen is in the milk stage, the permanent premolars and second and third molars not yet having erupted. The series is complete from the milk canine to the first permanent molar (m^1). M^2 is seen imbedded in the jaw while m^3 has not yet formed. The permanent p^3 is also embedded above the crown of dp^3. This interpretation is supported by the following observations: (1) The two alveoli of the most anterior cheek tooth indicate a two-rooted premolariform canine, as in the adult dentition of *Pliohyrax*, *Saghatherium*, *Megalohyrax*. (2) The crown of the tooth we have called m^1 is much less worn and more hypselodont than that of dp^4. (3) In *Hyrax* the milk teeth and m^1 are in use together, while m^2 is buried in the jaw, and m^3 has not yet formed; m^2 apparently comes into use during the replacement, while m^3 does not come into use until after the permanent premolars are all in place and more or less worn. As shown in the accompanying drawings, which are reproduced natural size, the cheek teeth are of the lophoselenodont type, that is, with short and very oblique well formed transverse crests in which the distinctness of the conules is apparent only on the protoloph. The ectoloph consists of two crescentic para- and metacones separated by a mesostyle which is far more prominent and distinct than in the existing genus *Hyrax*. The parastyle is also relatively more prominent. The internal cingulum is slightly less developed than in the milk teeth of *H. capensis*.

Milk Premolars.—Whereas in the type of *Saghatherium antiquum* the adult premolars exhibit imperfectly formed transverse crests

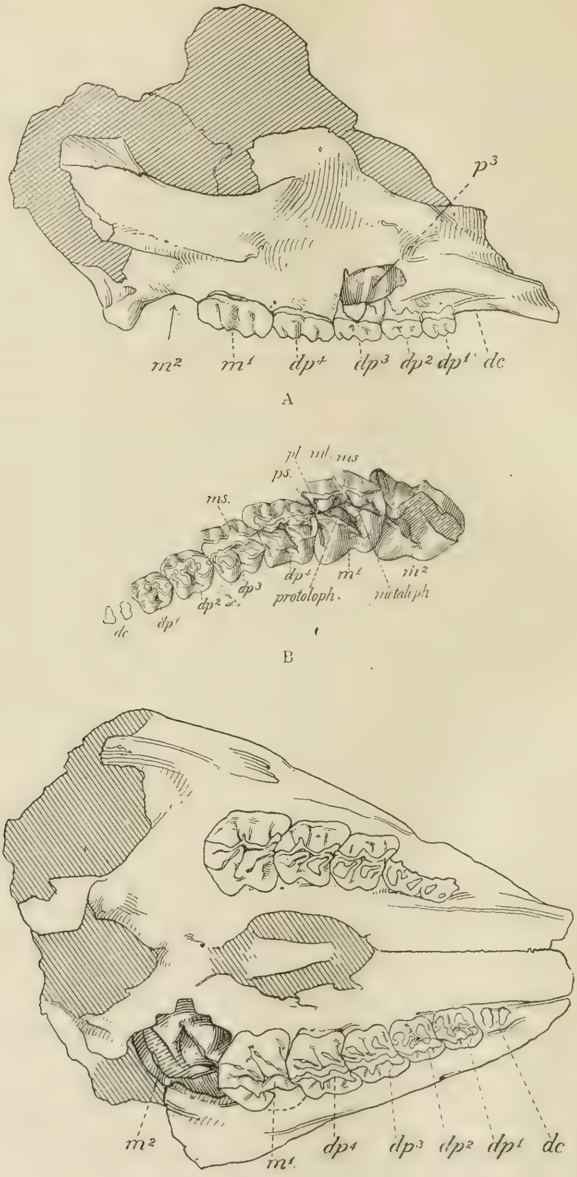

p^3
m^2
m^1
dp^4
dp^3
dp^2
dp^1
dc
A
pl ml. ms
ps.
ms.
dp^4
m^1
m^2
dp^3
protoloph.
metaloph
dp^2
dp^1
dc
B
m^2
m^1
dp^4
dp^3
dp^2
dp^1
dc
C

Fig. 1.—*Saghatherium antiquum* Andrews and Beadnell. No. 11570 Coll. Markgr. 1905, Stuttgart Museum. A, sideview of upper jaw and teeth; B, crown view of cheek teeth, left side; C, palatal view, upper jaw and teeth. All figures natural size.

in the milk dentition of the present specimen the premolars exhibit two well defined crests, protoloph and metaloph, and further resemble the molars in the presence of the mesostyle: on the whole the structure is simpler than that of the molars but of the same type. A small tubercle in the middle of the adult premolars of *S. antiquum* does not appear here.

COMPARATIVE MEASUREMENTS IN MILLIMETERS.

(Measurements of *Pliohyrax*, *Megalohyrax*, estimated from the published figures.)

	Hyrax capensis	*H. syriacus*	*Saghatherium minus* (type)	*S. antiquum* (No 11579 Stuttgart)	*S. antiquum* (type)	*Pliohyrax kruppii* (type)	*Pliohyrax græcus* (fide Forsyth Major)	*Megalohyrax eocænus* (type)
dc.–m^1, length	25	—	—	39	—	—	—	—
c–m^3, “	—	39	—	—	62	115	—	177
dc–dp^4 “	19	—	—	29	—	—	—	—
m^1–m^3 “	—	20	20	—	34	59e	85e	“86”
m^1 ant. post. *	6	7	—	8	8	19	19	24e
m^1 transv. †	6	7	—	9	10	21	26	27e
m^2 ant. post. *	—	8	—	11	10	20	25	27e
m^2 transv. †	—	7	—	10	11	21	31	33e
m^3 ant. post. *	—	7	—	—	12	—	40	35e
m^3 transv. †	—	7	—	—	11	—	35	30e

* Shortest ant. post. diam. along the middle line.

† Shortest transv. diam. mesostyle to mid-internal border.

The dimensions of the skull and position of the posterior opening of the palate may be obtained from the drawings. The palate appears to open more posteriorly than in the adult *H. syriacus*, but this is because m^3 has not yet been formed; the dental series converge more decidedly anteriorly than in the adult *H. syriacus*, but each tooth now is much less curved than in the milk dentition of that species.

This specimen decidedly confirms the general resemblance of these Eocene animals to the modern Hyracoids.

Comparison of the published figures and of the appended table of measurements brings out the following facts:

(1) *Saghatherium minus* may have been not much larger than *Hyrax syriacus*.

(2) *Pliohyrax græcus* is apparently separable from *Megalohyrax* by the oblique ectoloph of m^3, which ends in a backwardly produced spur, also by the greater hypselodonty and greater relative breadth of the molars.

(3) *Pliohyrax kruppii* is smaller than *P. græcus* but is apparently generically identical with it.

BIBLIOGRAPHY

Andrews, C. W., and H. J. L. Beadnell. A Preliminary Note on some New Mammals from the Upper Eocene of Egypt. *Survey Department Public Works Ministry*, Cairo, Egypt, 1902, pp. 5, 6, fig. 4 [*Saghatherium antiquum* and *S. minutus*.]

Andrews, C. W. Notes on an Expedition to the Fayûm, Egypt, with Descriptions of some New Mammals. *Geol. Mag.*, Dec. IV, Vol. X, No. 470, Aug. 1903, pp. 339–342, figs. 1, 2. [*Megalohyrax eocænus*.]

Major, C. J. F. The Hyracoid *Pliohyrax græcus* (Gaudry) from the Upper Miocene of Samos and Pikermi. *Geol. Mag.*, Dec. IV, Vol. VI, No. 426, December, 1899, pp. 547–553, pl. xxiv.

Osborn, H. F. On *Pliohyrax kruppii* Osborn, a Fossil Hyracoid, from Samos, Lower Pliocene, in the Stuttgart Collection. *Proc. Int. Congr. Zoölogy*, Cambridge, 1898, pp. 173, 174, pll. i, ii.

59, 57, 72 P (727.5)

Article XIV.—A NEW WINGLESS FLY (*PULICIPHORA BORINQUENENSIS*) FROM PORTO RICO.

By William Morton Wheeler.

Plate XXXIV

The genus *Puliciphora* was established by Dahl in 1897 for some wingless and halterless flies which he had collected in the Bismarck Archipelago on dead birds and the carrion-scented flowers of the Aroid *Amorphophallus*. Being of the opinion that these flies would shed a new light on the phylogenetic origin of the fleas (Aphaniptera) from dipterous insects, he named the new species *P. lucifera*, and assigned it to the well-known family Phoridæ. In the following year, Wandolleck, while studying the types or co-types of *P. lucifera*, found that Dahl had described two species under the same name; that he had, in fact, designated as the male of *P. lucifera* the female of another wingless and halterless species. As if to show his distaste for Dahl's views on the phylogeny of the fleas, and in utter disregard of all precedent among systematic naturalists, he brushed aside the name *Puliciphora lucifera* and substituted two new generic and specific names, calling the female of *P. lucifera*, *Stethopathus ocellatus*, and the supposed male, *Chonocephalus dorsalis*. These two insects, together with a third which in the meantime Cook had described from specimens collected on a Liberian land-snail (*Achatina*) as *Wandolleckia* (since named *W. cooki* Brues), were removed from the Phoridæ by Wandolleck and elevated to the rank of an independent family, the Stethopathidæ.

It is only too evident that Wandolleck's *Stethopathus ocellatus* is merely a synonym of Dahl's *Puliciphora lucifera*. It follows also that the word Stethopathidæ must be abandoned even if Brues had not shown that the three wingless genera supposed to consitutte this group are closely related to two older genera of subapterous flies (*Psyllomyia* Loew and *Ænigmatias* Meinert), and to several subapterous genera first described by Brues himself (*Ecitomyia*, *Commoptera*, *Xanionotum*, and *Acoustistoptera*). Brues's further discovery of the male of *Ecitomyia wheeleri*, which has well-developed wings with typical Phorid neuration, makes it very probable that all the other genera, which happen to be based on females only, have similar winged males. It is even doubtful whether we should follow the example of Melander and Brues and include all the apterous and subapterous Phoridæ in an independent subfamily. If this is insisted on, however, the group should be known as the Puliciphorinæ, unless, indeed, we revert to Loew's *Psyllomyia testacea* as the type. In that case, the subfamily should, of course, bear the name Psyllomyinæ.

There is opportunity for some difference of opinion in regard to the systematic position of the singular termitophilous and physogastric genera *Termitomyia* and *Termitoxenia* recently described by Wasmann. According to this author they represent an independent family which should be inserted between the Eumyid and Pupiparous sections of the order Diptera. He bases his opinion on his discovery that these insects are protandric hermaphrodites and develop directly, that is, without metamorphosis, from very large eggs. Brues regards these termitophiles as very aberrant Phoridæ, allied to the above-mentioned apterous and subapterous genera. While there can be little doubt that the forms in question have arisen from Phorid-like ancestors, it seems to me that the arguments adduced by Wasmann for regarding the Termitoxenidæ as a distinct family are not easily set aside. It may be contended, however, that we know nothing as yet of the development of the apterous and subapterous Phoridæ. The eggs of some of these insects seem to be very large, like the eggs of the Termitoxenidæ, so that it is not impossible that their development may be ametabolic or at least much abbreviated. This is most probable in some of the extreme forms like *Wandolleckia*, *Puliciphora*, and *Ænigmatias*.

The genus *Puliciphora* remained monotypic till 1903 when Melander and Brues found specimens of a second species (*P. occidentalis*) running on the ground in the immediate neighborhood of *Halictus* burrows at Wood's Hole, Massachusetts. As in the case of *P. lucifera*, only female specimens were taken. I am able to add a third species, which I recently captured in Porto Rico. On March 16, Professor N. L. Britton, Director of the New York Botanical Garden, handed me a large beetle (*Stratægus julianus* Burmeister) which he picked up while we were walking through the streets of Utuado. The beetle, which was nearly dead, was placed in a tin box with a perforated lid and left in my room at the hotel. On opening the box the following day I found that a lot of "crazy ants" (*Prenolepis longicornis* Latr.), together with a number of small Phoridæ, which I at first took to be *Podurans* allied to *Sminthurus*, had entered it through the small apertures. There was nothing to indicate any myrmecophilous relationship between the ants and the Phorids. Probably both had been independently attracted to the box by the strong odor of the decomposing beetle. The Phoridæ, which on closer examination were found to belong to an undescribed species of *Puliciphora*, were running about on the surface of the beetle and the adjacent walls of the box with a rapid skating gait, interrupted by quick turns and sudden halts. The beetle was examined at intervals of a few hours during the three following days, but though from one to half a dozen *Puliciphora* females were taken on each of these occasions, no males were to be found. It is not improbable that these have well-developed wings with a typical Phorid neuration like the males of *Ecitomyia wheeleri* Brues. I subjoin a description of the new species from the types in the American Museum of Natural History, and a list of the literature pertaining to the apterous and subapterous Phoridæ.

Puliciphora borinquenensis sp. nov.

(Pl. XXXIV.)

Female. Length, .7–1 mm.

Head slightly broader than long, with subparallel sides, straight posterior border and slightly convex and projecting front. Ocelli present. Eyes small, flattened, distinctly hairy. Antennæ set in deep frontal concavities, as in the other species of the genus; basal joint globose, second and third joints very small, cylindrical, subequal and, like the long arista, distinctly plumulose. Palpi long, projecting beyond the head when the latter is seen from above; in profile, their upper surfaces are straight or slightly concave, their lower surfaces convex. Proboscis well developed, projecting, laterally compressed, as long as the height of the head. The head has the following chætotaxy: There are four or five long macrochætæ on the outer apical surface of each palpus, four close together and projecting forward on the middle of the front, one on each side of the anterior ocellus, two between the posterior ocelli, and one at each of the extreme posterior corners of the head.

Thorax shorter than the head, but about twice as broad as long, a little narrower in front than behind, with feebly convex sides. It is as broad as the head, but hardly a third of the width of the greatest transverse diameter of the abdomen. There are no traces of either wings or halters. The pleuræ are steep and flattened, the three segments being very short and indistinctly indicated. On each side of the notum there are three macrochætæ, which increase in length from before backwards; the middle one is inserted further dorsally than the other two, the posterior higher than the anterior. Between the posterior pair, which occupies the extreme posterior corners of the thorax, there is a smaller pair near the posterior edge and about as far apart as each of them is from the posterior corner. There are very few hairs on the pleuræ.

Abdomen very voluminous, egg-shaped. The chitinous investment is thin and finely and very regularly chagreened, except on the dorsal surface, where there are six thickened sclerites, the first being very narrow, the last reduced to a minute lunule, the second as long as the subequal third and fourth together, the fifth narrow and with a large crescentic glandular opening in its middle. There are no ventral sclerites. The seventh, eighth, and ninth segments are suddenly attenuated, and the last bears a pair of small foliate flaps. The dorsal sclerites are covered with short uniformly distributed hairs; the remainder of the abdomen, except a large patch on each side just back of the hind leg and extending over about four segments, is covered with similar hairs, each of which arises from a small but conspicuous, elliptical brown spot. There is a circlet of macrochætæ along the posterior edge of the sixth and on the anterior portion of the much smaller seventh segment.

Legs rather stout, covered uniformly with short hairs except the coxæ which are nearly bare. Tips of hind coxæ with a row of bristles. Tibiæ with prominent spurs. Empodia fimbriated. Hind metatarsus slightly flattened and bearing on its plantar surface six transverse rows of bristles.

The body and legs are yellowish; abdomen white, except the dorsal sclerites and the spots from which the hairs arise, which are dark brown. Upper surface of head and thoracic dorsum light brown, the former with a dark brown, V-shaped mark with its angle over the ocelli, the latter with two indistinct longitudinal dark brown bands.

Described from nineteen specimens taken at Utuado, Porto Rico, March 17 to 19, 1906.

This species differs from both *P. lucifera* and *P. occidentalis* in having the hind metatarsi somewhat dilated and furnished with rows of bristles, and in the shape of the thorax, which is much longer than in *lucifera* and without the lateral sinuosities of *occidentalis*. From the former it differs also in the wider distribution of the stout hairs on the membranous portions of the abdomen. There are also important peculiarities in the chætotaxy of the new species, as may best be seen by comparing the figures accompanying this article with those of Wandolleck and Melander and Brues. It is, perhaps, worth noting that all the bristles of *P. borinquenensis* are bare, that is, non-pubescent, just as they are in *lucifera* and *occidentalis*.

BIBLIOGRAPHY.

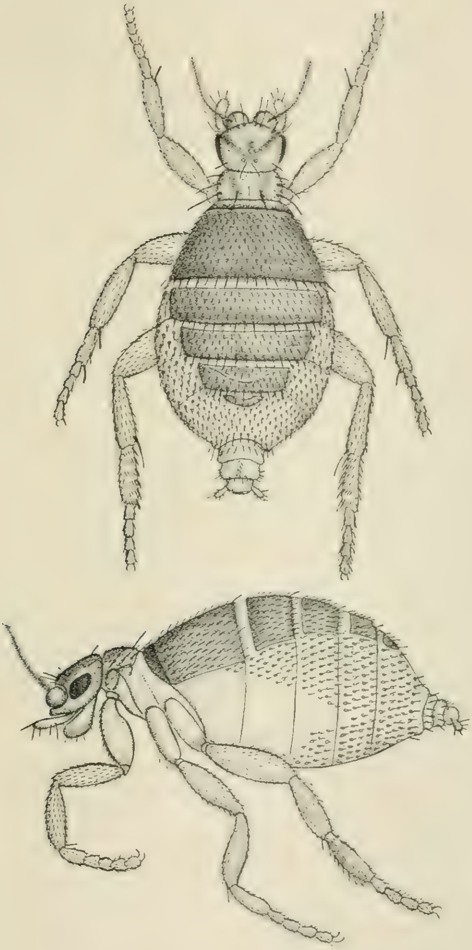
Becker, Th. Die Phoriden. *Abhand. zool. bot. Ges. Wien*, 1901, pp. 1–100, Taf. i–v.

Brues, C. T. Two New Myrmecophilous Genera of Aberrant Phoridæ from Texas. *Amer. Natur.*, XXXV, 1901, pp. 337–356, 10 figs.

Brues, C. T. New and Little-Known Guests of the Texan Legionary Ants. *Amer. Natur.*, XXXVI, 1902, pp. 365–378, 7 figs.

Brues, C. T. A Monograph of the North American Phoridæ. *Trans. Am. Entom. Soc.*, XXIX, 1903, pp. 331–404, pll. v–ix.

Cook, O. F. A New Wingless Fly from Liberia. *Science*, VI, Dec. 20, 1898, p. 886.



PULICIPHORA BORINQUENENSIS SP. NOV.

Coquillett, D. W. The Occurrence of the Phorid Genus Ænigmatias in America. *Canad. Entomol.*, XXXV, 1903, pp. 20–22.

Dahl, Fr. Puliciphora, eine neue, flohähnliche Fliegengattung. *Zool. Anzeig.*, XX, 1897, pp. 409–412. Translated by E. E. Austin in *Ann. Mag. Nat. Hist.*, VII, 1898, pp. 99–101.

Dahl, Fr. Ueber den Floh und seine Stellung im System. *Sitzber. naturf. Freunde Berlin*, 1898, p. 185.

Dahl, Fr. Ueber Puliciphora lucifera. *Zool. Anzeig.*, XXI, 1898, pp. 308, 309.

Loew, H. Psyllomyia testacea, eine neue Gattung der Phoriden. *Wein Entom. Monatschr.*, I, 1857, pp. 54–56, Taf. i, Figs. 22–25.

Meinert, F. Ænigmatias blattoides, dipteron novum apterum. *Ent. Med.*, II, 1890, pp. 212–226, pl. iv.

Melander, L., and C. T. Brues. Guests and Parasites of the Burrowing Bee Halictus. *Biol. Bull.*, V, 1903, pp. 1–27, 7 figs.

Wandolleck, B. Ist die Phylogenese der Aphanipteren entdeckt? *Zool. Anzeig.*, XXI, 1898, pp. 180–182.

Wandolleck, B. Die Stethopathidæ, eine neue flugel- und schwingerlose Familie der Diptera. *Zool. Jahrb., Abth. f. Syst.*, XI, 1898, pp. 412–441, Taf. xxv, xxvi.

Wasmann, E. Neue Dorylinengäste aus dem neotropischen und dem äthiopischen Faunengebiet.. *Zool. Jahrb., Abth. f. Syst.*, XIV, 1900, pp. 215–289, Taf. xiii.

Wasmann, E. Termitoxenia, ein neues flügelloses, physogastres Dipterengenus aus Termitennestern. I Theil, *Zeitschr. f. wiss. Zool.*, LXVII, 1900, pp. 599–617, Taf. xxxiii; II Theil, *ibid.*, LXX, 1901, pp. 289–298.

Wasmann, E. Zur näheren Kenntnis der termitophilen Dipterengattung Termitoxenia Wasm. *Verhandl. V. Internat. Zool. Congr. Berlin*, 1901, pp. 852–872, Taf. i.

Wasmann, E. Die Thorakalanhänge der Termitoxeniidæ, ihr Bau, ihre imaginale Entwicklung und phylogenetische Bedeutung. *Verhandl. deutsch. zool. Gesell.*, 1903, pp. 113–120, Taf. ii, iii.

Wasmann, E. Termitophilen aus dem Sudan. In Results of the Swed. Zool. Exped. to Egypt and the White Nile, 1901, under the direction of L. A. Jägerskiöld. Part I, Upsala, 1904, No. 13, 21 pp., 1 pl.

55.1,781 (78.7)

Article XV.—VOLCANIC ASH IN THE BRIDGER BEDS OF WYOMING.

By W. J. Sinclair.

Plates XXXV–XXXVIII.

It has been commonly assumed that the sediments referable to the Bridger stage of the Eocene of Wyoming are normal detrital deposits, and in the reports of the earlier governmental surveys[1] they are referred to as sandstones, shales, marls, limestones, and cherts.

During the past summer it was the writer's good fortune to accompany one of the field parties of the American Museum of Natural History operating, under the leadership of Mr. Walter Granger, in the area of Bridger beds lying north of the Uinta Mountains and west of Green River. This series of exposures extends as far west as Carter station on the Union Pacific Railroad and as far north as the junction of the Big Sandy and the Green. In addition to the routine palæontological work of the party, considerable data of geological interest were secured, including a suite of representative rock specimens from all horizons in the Bridger formation. These have recently been subjected to microscopical examination, with the surprising result that almost the entire Bridger group has been found to be of volcanic origin.

General Features of the Geology.

The Bridger formation in the area studied abuts uncomformably against the northerly dipping Palæozoic rocks of the Uinta Range. Its relations with the underlying Green River group have not been sufficiently investigated, but according to the Fortieth Parallel Survey[2] the Green River shales, a short distance west of Green River, pass with apparently a slight unconformity beneath the softer beds of the overlying Bridger group. On the west, in the vicinity of Carter station, the Bridger beds are said to lie with apparent conformity, but actual unconformity, on the Lower Green River.[3] North of Carter, the stratigraphic relations of the Bridger have not been carefully studied but there is reason to believe that between Carter and Opal it overlaps on the uptilted Wasatch, an erosional unconformity with discordance of dip existing between the two groups.

---

[1] Hayden. U. S. Geol. Survey of Wyoming and Contiguous Territory, pp. 55–58, 1871.
Powell. U. S. Geog. and Geol. Survey, Geology of the Uinta Mts., pp. 40, 45, 167, 1876.
Emmons. U. S. Geol. Exploration of the 40th Parallel, Vol. II, pp. 204, 244, 1877.
King. U. S. Geol. Exploration of the 40th Parallel, Vol. I, p. 394, 1878.

[2] King. U. S. Geol. Exploration of the 40th Parallel, Systematic Geology, Vol. I, p. 395.

[3] Powell. Geology of the Uinta Mountains, p. 63.

The Bridger beds are horizontal or nearly so, dipping so slightly toward the southeast that the gradient can be determined only by a series of carefully run levels. Black's Fork and its tributary, Muddy Creek, cut across the northwest portion of the area, exposing the lowermost beds in a line of bluffs extending to the northeast of Carter station. To the southeast, higher and higher levels are exposed in a series of terraces controlled by narrow but remarkably persistent hard beds which have influenced the development of the valleys of the smaller streams tributary to Black's Fork. The uppermost levels, remnants of which are preserved beneath the resistant Pleistocene conglomerate capping the mesas known as Sage Creek Mountain, Henry's Fork Hill, and Henry's Fork Table (the Turtle Bluffs of the Fortieth Parallel Survey map), have been entirely removed by erosion from the region farther north.

LITHOLOGIC AND STRATIGRAPHIC CLASSIFICATION OF THE BRIDGER GROUP.

On a lithologic and faunal basis the Bridger may conveniently be subdivided into three divisions of which the lower, exposed principally along Muddy Creek and Black's Fork, has been determined by Dr. Matthew and Mr. Granger[1] to be in the vicinity of 200 feet thick.

The Lower Bridger.—The Lower Bridger consists of buff and pale green tuffaceous shales and sandstones often containing in enormous numbers the shells of *Goniobasis*, *Paludina*, and *Unio*. Vertebrate fossils are rare and such as are present are aquatic types, mainly crocodiles, fish, and turtles.

Two specimens of Lower Bridger rocks collected in the immediate vicinity of Fort Bridger from layers abounding in shells have been studied by the writer. Both yield a brisk effervescence when treated with hydrochloric acid, showing the presence of considerable calcium carbonate, a characteristic of almost all the Bridger rocks irrespective of horizon. Microscopically examined, the insoluble residue is seen to be composed mainly of highly angular, splintered fragments of glassy sanidine, with a small amount of green hornblende and brown biotite. A considerable quantity of finely divided glass is also present. The glass in the Bridger is frequently devitrified. The glass needles shown in Plate XXXVII, Figure B, from a pumiceous tuff occurring at a considerably higher horizon are in this condition.

---

[1] A report on the faunal horizons of the Bridger group by Dr. W. D. Matthew and Mr. Walter Granger is in preparation. The writer is indebted to their manuscript for the statements regarding the thickness of the beds.

The Middle Bridger.—No sharp stratigraphic line can be drawn between the lower and middle subdivisions, although the two are separated sharply enough faunally. The Middle Bridger is magnificently exposed in the escarpment east of Smith's Fork known as the Grizzly Buttes, and also along Cottonwood Creek, Sage Creek, and Henry's Fork, attaining a total thickness of 1175 feet. The rocks of this division are fine grained, greenish tuffs; coarse, gray, pumiceous tuffs; white tuffaceous marls and shales; coarse, cross-bedded, green sandstones, often with basal conglomerates; cherts; limestones and thin beds of lignite.

The pale greenish tuffs are the most extensively developed and contain the best preserved vertebrate fossils. Water-white, splintered grains of sanidine and fragments of glass, sometimes devitrified, make up the bulk of this rock. Considerable green hornblende in narrow, lath-shaped fragments is present, with a subsidiary amount of angular quartz grains and foils of brown biotite. The calcareous component, removable by treatment with acid, is undoubtedly of organic origin and is probably derived from the comminuted shells of *Unio*, of which the disarticulated valves occur throughout these tuffs at various horizons. On weathering, this rock assumes the topographic forms shown in the foreground of Plate XXXVI.

The coarse, gray, pumiceous tuffs are especially well developed a few feet above the prominent bed of white tuffaceous marl shown in the middle distance in Plate XXXV, where they occur in lenticular masses frequently containing rolled pebbles as well as angular fragments of pumice. The pumice grains contain needle-like crystals of hornblende. The glass in the pumice (Pl. XXXVII, Fig. B) is devitrified. The rock is soft and incoherent. Calcareous material is practically absent, pumice in fine powder acting as the cementing substance of the coarser grains. Green hornblende in stubby columns and pale brown mica are abundant. Glassy sanidine and splintered grains of quartz occur in large numbers but the mass of the rock is glass either in the form of pumice or in fine, pale brown needles. This material has apparently accumulated too rapidly to contain much in the way of vertebrate fossils. A skull of *Isectolophus* is the only specimen yet found in it.

Beds of white marly tuff and white, tuffaceous shale occur at four horizons in the Middle Bridger. These white beds (Pll. XXXV, XXXVI) vary in thickness from one to twelve feet and are traceable for long distances as rim rocks in the valley escarpments. Laterally, they cover areas many square miles in extent and have played an important part in the development of the terraces previously mentioned, and have also influenced in a marked degree the development of the valleys of some of the smaller streams.

The marly facies is composed of the shells of fresh-water gastropods of the genus *Planorbis*, but in addition to the calcareous component, there is a large amount of siliceous material of volcanic origin. Fine fragments of glass predominate, with an occasional flake of sanidine and needle of hornblende. Locally, the marl may pass into a pale gray limestone as at the summit of the westerly extension of the Grizzly Buttes, but even in this the volcanic ejecta may be discovered in the insoluble residue remaining after treatment with acid. Highly angular fragments of glassy sanidine, bounded by fracture and cleavage planes form the largest percentage of the insoluble residue, but a smaller amount of hornblende, biotite and quartz is also present, as well as glass in finely divided particles. Lignitic bands, sometimes with a basal layer of fire clay, are frequently associated with the tuffaceous marls, registering a transition from lacustrine conditions to peat bogs (Pl. XXXVIII). Remains of insectivores and other small mammals are found in great abundance in certain of the white layers or at the contact between the white layer and the bed lying immediately beneath, showing that the lakes and ponds in which the marls accumulated were the favorite haunts of the Eocene microfauna.

White tuffaceous shales occasionally showing indistinct plant impressions form the greater part of certain of the white layers. In these shales, segregation of the silica has taken place, producing lenticular sheets of black chert varying from a fraction of an inch to several inches in thickness. The chert has been used by the Indians as a source of material for arrow points.

At all horizons in the Middle Bridger massive lenses of coarse-grained green tuff-sandstone are common (Pl. XXXVIII), often with a basal conglomerate of flattened pebbles of greenish tuffaceous shale. Water-worn bones and teeth, *Unio* shells, and thin bands of pebbles are common in the sandstone. Cross-bedded structures are frequently observable. The pebbles in the conglomerate bands are usually black chert and indurated tuff shale, but pebbles of apparently a scoriaceous rhyolite are not uncommon. The finer grains are mainly sanidine, with fragments of black chert and various Bridger shales. A large amount of green hornblende and numerous foils of biotite are present, the latter often preserving more or less perfectly the hexagonal outlines of the cleavage flakes. Glass occurs abundantly in the fine dust which often forms a coating over the coarser grains, acting together with the large amount of calcium carbonate present as the cementing substance of the rock. The highly angular character of the sanidine grains shows conclusively that they have not been subjected to long continued abrasion by the transporting agents, whether wind or water or both, and suggests that these deposits accumulated rather rapidly in the swifter reaches of sluggish streams. An occasional more or less rounded grain is present.

Numerous veins of calcite and gypsum are common in the Middle Bridger, usually forming the capping of small terraces. Cylindrical aggregates of barite, showing a radial structure in cross section, occur in the soft tuffs.

The Upper Bridger.—The Upper Bridger is sharply differentiated from lower levels by its high gypsiferous content. Its thickness may be fixed approximately at 500 feet. Lithologically, the Upper Bridger is composed of red, green and buff gypsiferous tuffs, white tuffaceous marls, and beds made up almost entirely of sanidine grains and glass either in the form of pumice or in fine fragments. Lignitic bands and black cherts similar to those described in treating of the Middle Bridger rocks occur locally. The gypsum in the Upper Bridger either takes the form of large spear-shaped crystals or is distributed through the tuffs as the cementing substance. In certain of the reddish tuffs it occurs in discoidal, worn grains. A large amount of calcium carbonate is present, associated with the gypsum, as well as considerable oxide of iron in the red tuffs. A sample of the latter examined microscopically, after digestion in acid, is seen to be composed of numerous small discs of gypsum and an abundance of a finely divided, pale greenish siliceous material, feebly polarizing, which is probably devitrified glass. Toward the top of the Upper Bridger, beds of fine white tuff occur on both Sage Creek Mountain and the southerly facing escarpment of Henry's Fork Mesa (Turtle Bluffs). These are composed almost entirely of sanidine and glass, but in the specimen shown in Plate XXXVII, Figure A, minute laths of green hornblende and foils of brown biotite are also present although not seen in the figure. The only fossils thus far discovered in the Upper Bridger have been a few fragments of the carapace of a turtle.

THE WYOMING CONGLOMERATE.

Although not a part of the Bridger group, the Wyoming conglomerate exercised such an important function in preventing the erosion of the Upper Bridger beds and is in such strong lithologic contrast to the whole Bridger series that a brief description of its principal characters will not be out of place here.

The Wyoming conglomerate of the Fortieth Parallel Survey (apparently the same as the Bishop's Mountain conglomerate of Powell[1]) forms the cap rock of Sage Creek Mountain, Henry's Fork Table and Henry's Fork Hill, extending with increasing thickness to the south into the Uinta Mountains. It is a coarse conglomerate of water-worn pebbles and boulders, mainly of Pink Uinta quartzite in a calcareous matrix. It occurs in place in the mesas just mentioned, resting with apparent conformity on the Upper Bridger, but pebbles derived from it are scattered over the entire Bridger area (Pll. XXXV, XXXVI), over the greater portion of which it may have originally extended. Judging from the amount of erosion which has occurred since its deposition, its age may be regarded as probably Pleistocene.

MODE OF ACCUMULATION OF THE BRIDGER BEDS.

With the problem of the origin of the Bridger beds in mind, the writer searched carefully for any trace of material which might be regarded as derived by erosion from an older series, but not the least indication of such detrital deposits has been found. Although pebbles and boulders of all the rocks of the Uinta range occur in the Wyoming conglomerate, not a fragment derived from such sources has been found in place in the Bridger. The conclusion appears to be well established that the drainage from the Uinta Range during this stage of the Eocene did not reach the Bridger area. The volcanic nature of the Bridger sediments appears fully established from the abundance of sanidine grains and glass fragments. The fine grain, high angularity, and great homogeneity of these volcanic products is opposed to the idea that they were transported from a distance by streams, as under such circumstances it seems inevitable that a certain amount of admixture with foreign material must take place. On the contrary, such deposits in the Bridger as are referable to stream action have derived their material entirely from Bridger sources, with the exception of the rhyolitic pebbles noticed above which may represent the scoriaceous facies of the acid magma from which the Bridger tuffs were derived. Apparently the greater portion if not all of these tuffs were distributed from the eruptive centers by the wind. The location of the explosively erupting vents is at present unknown, but there is no reason to think that they were located in the Uinta Range.

---

[1] Powell. Geology of the Uinta Mountains, pp. 160-171.

While it is believed that the wind was the principal transporting agent, there is positive evidence that a large part of the Bridger was either deposited in water or worked over by it to a considerable extent within the area of deposition. The tuffaceous shell marls may be regarded as lacustrine. The lakes in which they accumulated were remarkably wide but probably rather shallow, at least locally, and subject to fluctuations in level as shown by the accumulations of lignite which alternate with beds containing fresh water shells. The coarse sanidine sands with basal conglomerates, cross-bedding and bone pebbles are believed to be stream or delta deposits, while the fine grained greenish tuffs with frequent shells of *Unio* and abundant fish and mammal remains may be in large part flood-plain deposits.

That the Bridger accumulated in a base-leveled area may be inferred from the general absence of coarse material such as would be transported by high grade streams. The lack of kaolinization in the sanidine grains might suggest aridity but may mean nothing more than rapid burial and the absence of acidulated waters.

From the large number of fish, turtles and crocodiles in the Lower Bridger and the thin-bedded character of much of the tuff of this horizon it is believed that these beds are largely lacustrine. The Middle Bridger is partly lacustrine as shown by the tuffaceous marls and partly fluviatile as indicated by the cross-bedded sands. Wind blown sands have not been recognized, or, if such exist, the sand grains have not travelled far, as round grains are prevailingly absent. The gypsum in the Upper Bridger indicates aridity, which probably explains the almost entire absence of vertebrate remains. It is believed that these beds were deposited in playa lakes.

Princeton University,
April, 1906.

EXPLANATION OF PLATE XXXVIII.

Detail of one of the white bands in the Middle Bridger exposed in the east bank of Sage Creek at Sage Creek Spring.

1. Pale greenish tuff with narrow veins of calcite and gypsum, base concealed by talus.

2. Impure lignite inclosing lenses of tuff. Average thickness about 2½ inches.

3. Pale greenish tuff, 4½ feet.

4. Buff tuffaceous marl, with numerous shells of fresh water molluscs, 1–1½ feet.

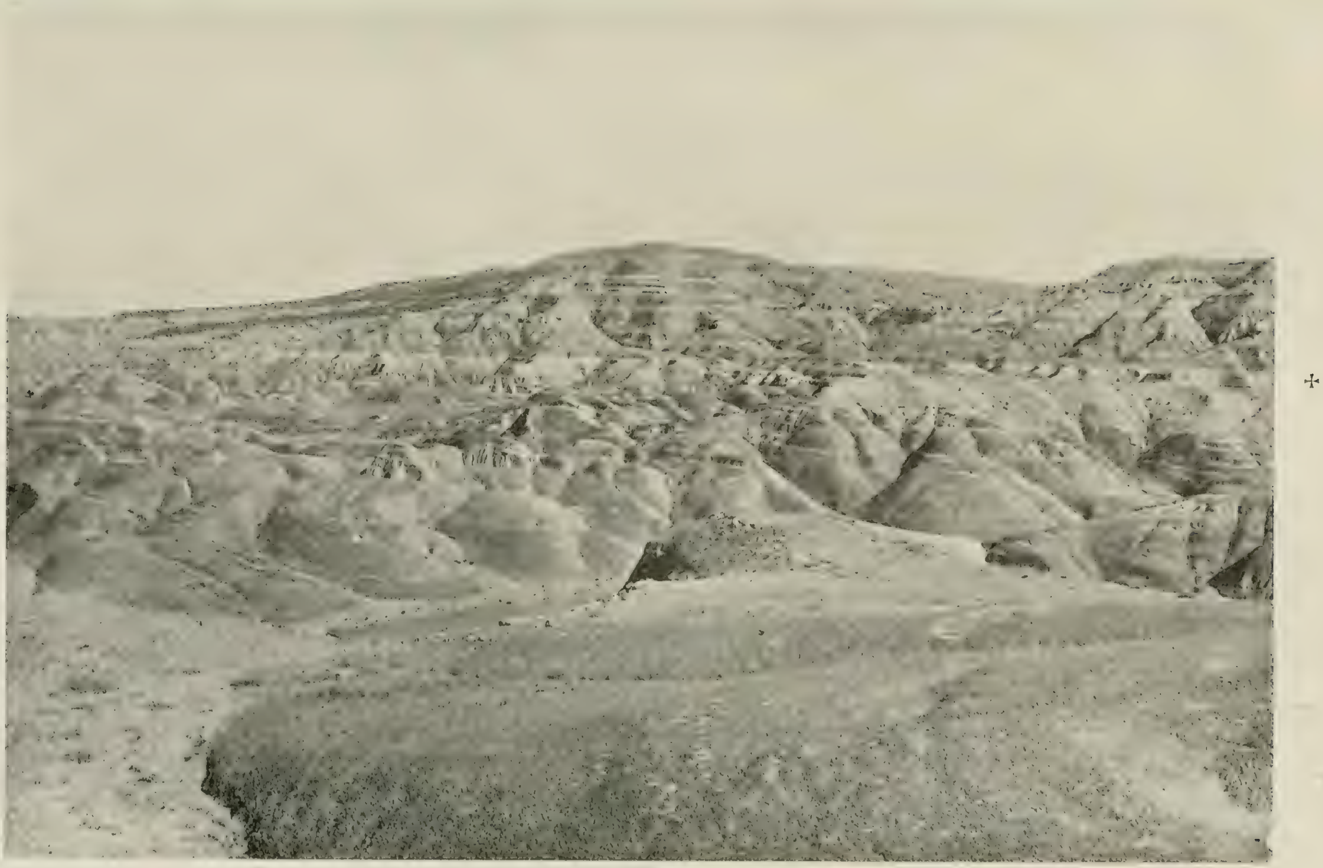
5. Tuff similar to numbers 1 and 3. Thickness about 6½ feet.

6. Tuffaceous marl, locally approaching a limestone, with abundant shells of fresh water gastropods. Thickness about 5 feet.

7. Impure lignite with obscure traces of plant remains. Thickness variable but seldom in excess of 2½ inches. The lignite grades into lignitic tuff with calcite and gypsum veins and this finally into a black chert occurring in lenses of varying thickness. Total thickness, excluding lignite, about 15 inches.

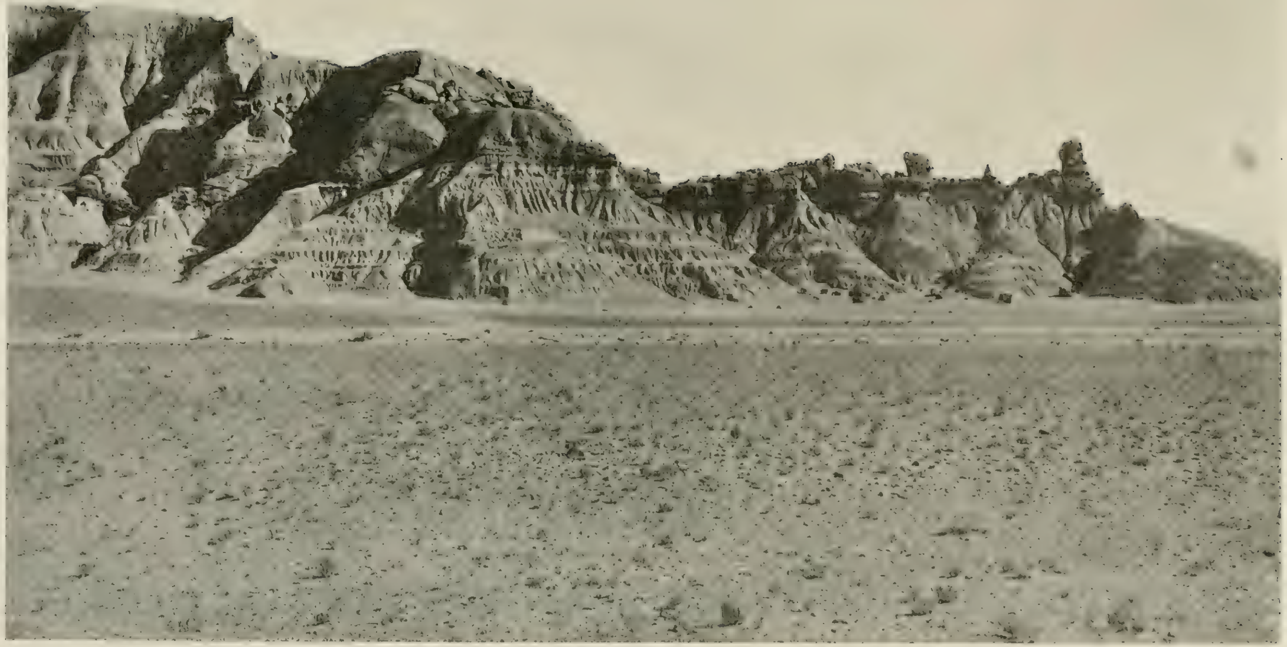
8. White tuffaceous shale with imperfect plant impressions. Thickness about 4½ feet.

9. Yellow tuff-sandstone. Top covered by an alluvial deposit (10) with pebbles derived from the Wyoming conglomerate.



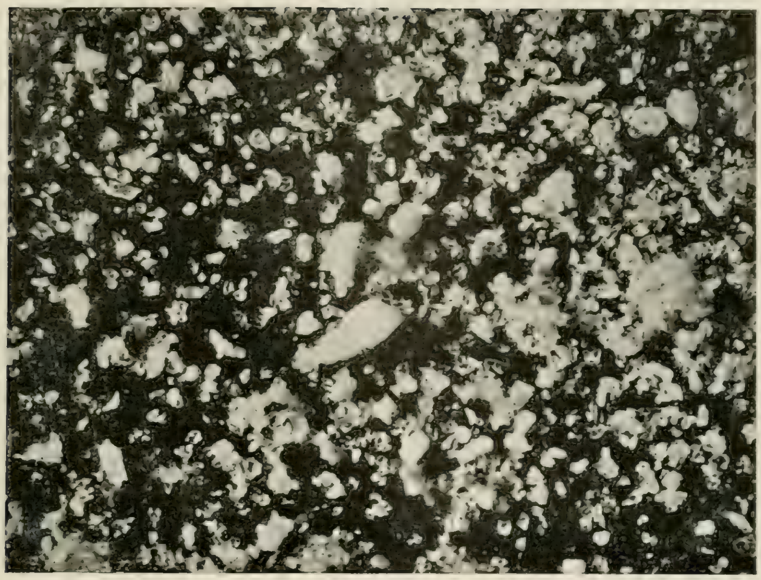
HENRY'S FORK HILL.

Tuffaceous marl band shown in middle distance (✠).

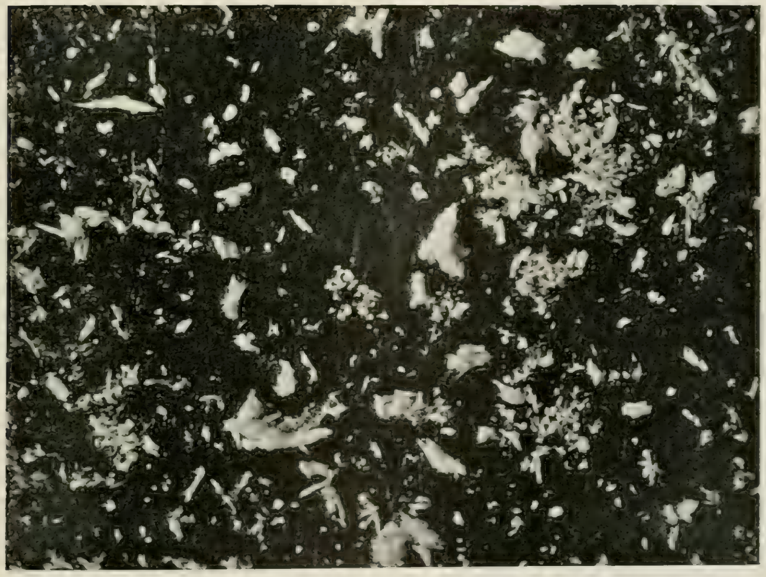


GRIZZLY BUTTES EAST.

A bed of coarse, green tuff-sandstone caps the promontory on the right.



A.

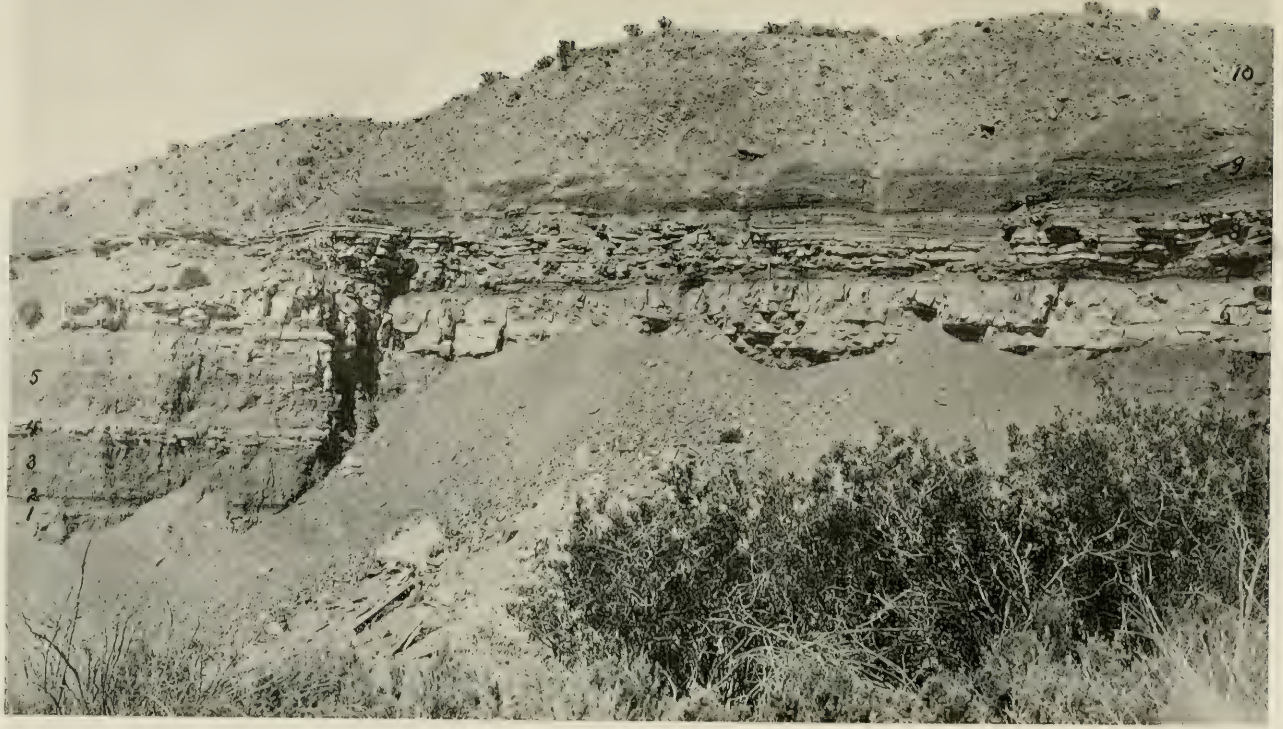


B.

Photo-micro by G. Van Ingen.

BRIDGER TUFFS.

A.—Sanidine tuff from the Upper Bridger, showing abundant sanidine grains and glass fragments.
B.—Pumice from a Middle Bridger Tuff. The grains are composed of a pale brown devitrified glass.
Both figures are enlarged eighteen diameters.


10
9
8
6
5
4
3
2
1

Sage Creek Spring.

Detail of one of the white layers.

59.57.96 (52)

Article XVIII.—THE ANTS OF JAPAN.

By William Morton Wheeler.

Plate XLI.

The following paper is based on a larger collection of ants made by Mr. Hans Sauter, mainly at Okayama, Kanagawa, and Yamanaka during the summer of 1904 and the spring of 1905 and sent me by Mr. Alan Owston of Yokohama, and some smaller collections from Misaki and other localities, sent me by Professor J. F. Abbott and Dr. W. H. Ashmead. Although this material has enabled me to recognize a number of the forms described by previous myrmecographers and to add several new ones, it is nevertheless true that our knowledge of the Japanese ant-fauna still remains very meager and unsatisfactory. Of very few of the species are all the castes known, and the published descriptions have often been drawn from a few or even single specimens. Moreover, ants have been collected in only a few localities of the Japanese archipelago. Probably, therefore, the described species and varieties will suffer considerable amendment when more material becomes available. The Japanese themselves seem to have paid little attention to the ants, unless perchance the results of their studies on these insects are embodied in works in their own language inaccessible to the occidental student.

Meager as are the materials at hand, however, they nevertheless throw considerable light on the geographical distribution of the Formicidæ in Eastern Asia. Forel called attention to the fact that the ant-fauna of Japan "consists of a mixture of palearctic and Malayan stocks, the latter confined for the most part to the southern portion of the archipelago." He fancied he could detect also "certain very interesting nearctic affinities, for example in *Camponotus pennsylvanicus* var. *japonicus* and *Formica fusca* var. *nipponensis.*" I believe that these affinities are somewhat doubtful. *C. japonicus*, being probably as closely related to certain Old World forms of *herculeanus* as it is to our common North American forms, should probably constitute a distinct subspecies of *herculeanus* independent of *pennsylvanicus*, and *F. nipponensis* is certainly as distinct from our North American var. *subsericea* as it is from the typical *fusca* of Europe.

There is, of course, no question as to the closer relationship between the Japanese ant-fauna and that of the adjacent East Asiatic continent. The complexion of the former, however, is altered by the intrusion, mainly, as Forel suggests, in the southern part of the archipelago, of a number of forms with strong Malayan or Indian affinities, in some cases even identical with the species of southern Asia. Such are the following:

Euponera solitaria,
Pheidole nodus,
Monomorium floricola,
Monomorium nipponense,
Monomorium triviale,
Vollenhovia emeryi,
Pristomyrmex japonicus,
Strumigenys lewisi,
Iridomyrmex itoi,
Iridomyrmex abbotti,
Technomyrmex gibbosus,
Colobopsis rothneyi,
Polyrhachis lamellidens.

The relationship of the Japanese to the European and North Asiatic ant-faunas is beautifully shown in the following list of identical species:

Myrmecina graminicola,
Solenopsis fugax,
Cremastogaster sordidula,
Myrmica lævinodis,
Myrmica lobicornis,
Tetramorium cæspitum,
Lasius umbratus,
Lasius niger,
Lasius fuliginosus,
Lasius flavus,
Formica rufa,
Formica sanguinea,
Formica fusca,
Camponotus herculeanus,
Camponotus marginatus.

In the majority of cases the subspecies or varieties which represent these species in Japan are much more closely related to the European types than to the North American subspecies and varieties.

The following list embraces forms which are known only from Japan, though in many cases these have pronounced affinities with other palearctic species, subspecies and varieties:

Sysphincta watasei,
Ectomomyrmex japonica,
Pseudoponera sauteri,
Brachyponera solitaria,
Ponera japonica,
Myrmecina nipponica,
Pheidole nodus,
Pheidole fervida,

Messor aciculatus,
Leptothorax congruus,
Leptothorax spinosior,
Pristomyrmex japonicus,
Monomorium nipponense,
Monomorium triviale,
Cremastogaster laboriosa,
Cremastogaster osakensis,
Stenamma owstoni,
Vollenhovia emeryi,
Aphænogaster famelica,
Iridomyrmex itoi,
Iridomyrmex abbotti,
Technomyrmex gibbosus,
Prenolepis flavipes,
Formica yessensis,
Formica fusciceps,
Formica nipponensis,
Camponotus obscuripes,
Camponotus vitiosus,
Camponotus 4-notatus,
Camponotus brunni.

Perhaps the most interesting of the new forms described in the following pages are *Sysphincta watasei*, *Myrmecina nipponica*, *Stenamma owstoni*, and *Vollenhovia emeryi*. These forms, with the exception of the last, have decidedly palearctic and nearctic affinities.

In working over the materials for the following revision of the Japanese ants I have been greatly aided by Professor Emery, who has taken the trouble to compare several of my specimens with the types of allied species in his extensive collection and has generously given me his expert opinion on the status of some of the new forms.

Family FORMICIDÆ.

Subfamily Ponerinæ.

1. **Sysphincta watasei,** sp. nov.

Worker (Plate XLI, Fig. 5). Length 4 mm.

Mandibles with oblique blades, 5–6-toothed; the three basal teeth blunt. Head, excluding the mandibles, longer than broad, with rounded posterior angles. Cheek with a short carina anteriorly. Eyes very small, near the middle of the lateral surface. Clypeus very short, its compressed middle portion projecting in front as a prominent blunt tooth between the high and approximated frontal carinæ. Antennal scapes thickened towards their tips and somewhat curved, reaching to the posterior corners of the head; joints 1-10 of the funiculus about as long as broad, terminal joint barely as long as the three preceding joints together. Thorax in profile convex in front, flattened behind, laterally compressed, much broader in front than behind. Epinotum with two indistinct teeth above, connected by a transverse ridge and each continued down on the side as a ridge bordering the concave epinotal declivity. Petiole from above longer than broad, broader behind than in front; in profile with a convex rounded node above, and below near its middle with a sharp tooth. Postpetiole campanulate, twice as broad as the petiole, not longer than broad; in profile flattened above, especially in front. First gastric segment somewhat broader and twice as long as the postpetiole, convex above; remaining gastric segments prominent, forming a cone which is bent forward and has a base occupying the posterior ⅔ of the ventral surface of the first gastric segment. Sting well developed. Legs rather long and robust.

Mandibles, appendages and body opaque, with the exception of the gaster which is shining. Mandibles finely striated. Head, thorax and pedicel densely punctate or granular, the surface becoming more uneven on the epinotum, petiole and postpetiole. Upper surface of postpetiole almost rugulose. Gaster very finely punctate.

Body and appendages covered with rather long yellowish pubescence, interspersed with longer, suberect hairs of the same color.

Rich ferruginous red, gaster somewhat paler, mandibular teeth, edges of clypeus and frontal carinæ blackish.

Female (deälated). Length 4.8 mm.

Resembling the worker except in the usual sexual characters, namely, the presence of the ocelli, the larger eyes and the structure of the thorax. The wing insertions and thoracic sutures are black. The ventral tooth of the petiole is in the middle of the segment as in the worker. The first gastric segment is distinctly broader than the postpetiole.

Described from single worker and female specimens collected by Mr. H. Sauter, the former at Okayama, Bizen, the latter at Kamakaur on the Sagami Gulf "under drift-wood on the sea-beach." This species, which I take pleasure in dedicating to my old friend Professor Sho Watasê of the Imperial University at Tokio, very closely resembles the other known species of the genus, namely the three Mediterranean species *S. europæa*, *algirica*, and *mayri*, and the two North American species *melina* and *pergandei*. The Japanese species may be distinguished from all of these except *S. algirica* by its flatter postpetiole, from *algirica* by the position of the ventral petiolar tooth, which is in the middle and not at the anterior end of the segment.

2. **Pachycondyla (Ectomomyrmex) japonica** *Emery.*

Emery, Rendic. R. Accad. Sci. Ist. Bologna, Ann. 1901, p. 12 (sep.) 1, ☿

This ant, of which I have seen no specimens, was described from the Island of Tsushima, between Japan and Corea.

3. **Pachycondyla (Pseudoponera) sauteri** sp. nov.

Plate XLI, Fig. 66, *a*.

Worker. Length 3–3.5 mm.

Head longer than broad, narrower in front than behind, with straight posterior border. Eyes very small, of one or two ommatidia, situated about ⅙ the distance from the anterior to the posterior corner. Mandibles broad, triangular, 7–8-toothed, with rather straight outer borders. Clypeus short, its anterior border nearly straight, its middle portion projecting between the carinæ as a small rounded protuberance. Frontal groove distinct, extending back beyond the middle of the head. Antennal scapes incrassated at their tips and not reaching the posterior corners of the head by a distance equal to twice their greatest diameter. First funicular joint nearly as long as the three preceding joints taken together; second joint as long as broad, joints 3–7 distinctly broader than long; joints 8–10 as broad as long; terminal joint nearly as long as the three preceding joints and forming with them a 4-jointed club, which is much thicker than the basal portion of the funiculus. Thorax with pronounced promesonotal and mesoëpinotal sutures; pronotum somewhat narrower than the head, rounder in front and on the sides, nearly twice as broad as long; mesonotum shorter and narrower than the pronotum, slightly convex; epinotum as long as the pronotum, but only half as broad, laterally compressed, its basal surface in profile straight, slightly lower than the mesonotum, distinctly longer than the declivity which is abrupt and has rounded lateral edges. Petiole from above as broad as the epinotum, somewhat broader than long, broader behind than in front; in profile a little higher than the epinotum, narrower above than below, with flattened and vertical anterior, truncated upper, and somewhat convex posterior, surfaces. Constriction between the first and second gastric segments rather indistinct. Legs stout; those of the middle and hind pairs, each with a pectinated and a simple spur; middle tibia and metatarsus bristly on their extensor surfaces, the latter joint much shorter than the hind metatarsus.

Clypeus and mandibles very smooth and shining, the latter sparsely and coarsely punctate. Head opaque, densely and finely punctate, frontal groove shining. Thorax, abdomen and appendages subopaque or in some specimens shining, more sparsely punctate than the head.

Body and appendages covered with yellow pubescence and suberect hairs of the same color, which are most conspicuous on the gaster and legs.

Mandibular teeth black, remainder of the body uniformly ochraceous.

Female, Length 4 mm.

Differs from the worker in color, the upper surface of the head, except its anterior third, the petiole and gaster dark brown or blackish. In some specimens this color extends over the sides of the mesonotum and the upper surface of the pronotum. Wings opaque, distinctly and uniformly infuscated.

Described from a number of workers and females (mostly deälated) taken by Mr. Hans Sauter, March 25, '05 at Yamanaka, Suruga ("1700 ft.; under stones"), and April 15, '05 at Takakiyama, near Kanagawa on the Sagami Gulf.

This species is closely allied to the palearctic *P. ochracea* Mayr, of which Professor Emery has sent me a worker and a female specimen. The Japanese species is darker in color and has a shorter head, which is broader behind with its sides converging anteriorly and thicker antennæ with more club-shaped funiculi.

4. **Euponera (Brachyponera) solitaria** *F. Smith.*

PLATE XLI, FIG. 13.

Ponera solitaria F. SMITH, Trans. Ent. Soc. London, 1874, p. 404, ☿

Ponera solitaria MAYR, Verh. zool. bot. Ges. Wien. XXXVI, 1886, p. 363.

Ponera solitaria FOREL, Bull. Soc. Ent. Suisse, X. 7, 1900, p. 267 and 284, ☿ ♀

Euponera (*Brachyponera*) *solitaria* EMERY, Ann. Soc. Ent. Belg., XLV, 1901, p. 47.

Several workers and deälated females collected by Mr. Hans Sauter during March and April 1905, at Kanagawa near Yokohama. Forel's specimens of the workers and females arrived in Hamburg in a living condition with plants (*Prunus*) imported from Japan. As Forel has shown, this species is allied to the two Indian species, *luteipes* Mayr and *jerdoni* Forel. It differs from both of these in having the posterior border of the head less deeply excised.

5. **Ponera japonica** sp. nov.

Worker. Length 2–2.25 mm.

Mandibles with three larger apical, and numerous minute basal teeth. Head excluding the mandibles, fully 1½ times as long as broad, nearly as broad in front as behind, with subparallel sides; occipital border slightly concave. Antennal scapes not reaching the posterior corners of the head by a distance equal to their greatest transverse diameter. All the funicular joints, except the first and last, distinctly broader than long; basal joints very short and narrow, four terminal joints forming a thickened club, which is distinctly longer than the remainder of the funiculus. Last joint about as long as the three preceding subequal joints. Eyes minute, consisting of only a few ommatidia and situated about ⅛ the distance from the anterior to the posterior border of the head. Thorax from above much broader in front than behind, in profile with straight dorsal surface and distinct promesonotal and mesoëpinotal sutures. There is also a distinct suture between the mesonotum and mesopleuræ. Mesonotum about ½ as long as the pronotum; basal surface of epinotum about as long as the declivity, which is distinctly flattened but hardly marginate on its sides. Petiole thick, nearly as long as broad, from above broader behind than the epinotum; in profile as high as the epinotum and gaster, flattened in front and behind and above, laterally compressed below and armed with a small median ventral tooth. Gaster and legs of the usual shape.

Head subopaque, very finely and densely punctate, thorax and abdomen more shining, more sparsely and more finely punctate.

Pubescence and hairs grayish yellow, longest and most conspicuous on the upper surfaces of the head, thorax, and gaster.

Reddish brown; upper surface of body dark brown; mandibles, clypeus, frontal carinæ, antennæ, and legs yellow.

Female. Length 2.7 mm.

Resembling the worker, but the body is darker in color and the petiole is proportionally shorter, with flatter anterior and posterior surfaces. The upper surface of the thorax is almost as coarsely punctate as the head but more sparsely. The basal surface of the epinotum is only about half as long as the declivity.

Described from two deälated females and several workers taken by Mr. Hans Sauter at Yamanaka, Suruga, on the western slope of the Hakone Mountains.

This species is closely related to the palearctic and nearctic *P. coarctata* Latr., but differs in its smaller size, thicker petiolar node, and shorter antennæ. The scapes do not reach so far back on the head, and the funiculus has much shorter basal and more club-shaped terminal joints. The sculpture and pilosity closely resemble those of *coarctata*.

Subfamily MYRMICINÆ.

6. **Myrmecina graminicola nipponica** subsp. nov.

The worker of this subspecies, like that of the typical European form, has well-developed median and lateral clypeal teeth, and the two pairs of teeth on the epinotum are similar, except that the posterior pair are somewhat broader and blunter in the Japanese specimens. The sculpture of the head, thorax and pedicel is much more pronounced than in the European and North American forms. It consists of coarse longitudinal, more or less anastomosing rugæ, especially on the head and thorax. Pilosity and color as in the European type. Length 3 mm.

Two workers collected by Mr. Hans Sauter at Yamanaka, Suruga.

7. **Solenopsis fugax** *Latreille.*

This well-known European species is cited by Ernest André as occurring in Japan. (Bull. Mus. d'Hist. Nat. Paris, 1903, p. 128, ☿)

8. **Pheidole nodus** *F. Smith.*

Pheidole nodus F. SMITH, Trans. Ent. Soc. London, 1874, p. 407, ♃
Pheidole nodus MAYR, Verhandl. zool. bot. Ges. Wien, XXXVI, 1886, p. 363.
Pheidole nodus FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 268, ♃ ☿

Soldier (Plate XLI, Fig. 8). Length 4–4.5 mm.

Allied to *Ph. striativentris* Mayr of India. Mandibles convex, flattened on the outer surface towards the base, with two apical teeth and a small basal tooth. Head, excluding the mandibles, but little longer than broad, somewhat narrower in front than behind; posterior angles rather acute, posterior border broadly excised, median dorsal surface convex. Eyes one third the distance from the anterior to the posterior corner, convex. Clypeus short, very flat or slightly concave in the middle, with a deep median notch in the anterior border and a distinct median keel. Frontal area carinulate in the middle, concave, fused with the clypeus. Frontal carinæ low, but very long and diverging, extending to within a short distance of the posterior corners of the head and forming shallow scrobes as long as the antennal scapes. Antennæ slender; scape curved at the base, very slightly enlarged towards its tip, which reaches half way between the eye and the posterior corner of the head; funicular joints 1–8 a little longer than broad; three terminal joints subequal, slender, together longer than the remainder of the funiculus. Thorax less than half as broad as the head, hardly broader through the pro- than through the epinotum, constricted in the mesothoracic region; pronotum rounded on the sides but with distinct humeri. There is a well-marked transverse depression across the posterior pronotal surface and also a distinct promesonotal depression. Epinotum with two sharp spines directed upward and outward, twice as far apart as long and longer than broad at their bases. The basal and declivous surfaces of the epinotum form almost a continuous sloping surface between the spines. Petiole barely half as broad as the epinotum, 1½ times as long as broad and distinctly broader in front than behind, with sides slightly concave in the middle; node transverse, in profile high and rather acute, with long concave anterior, and short concave posterior slope. Postpetiole more than three times as broad as the petiole, about 1½ times as long as broad, with very convex and much rounded dorsal surface and the sides produced in the middle as blunt angles. Gaster about twice as broad as the postpetiole, much smaller than the head. Legs rather long and slender.

Mandibles smooth and shining, with coarse, scattered punctures; on the outer surface near the base with coarse longitudinal rugæ. Clypeus shining, longitudinally rugose on the sides. Head subopaque, coarsely, longitudinally and reticulately rugose throughout. Even the antennal scrobes are crossed by rugæ. Between the rugæ the surface is finely punctate. Pronotum and base of epinotum transversely rugose, the latter more delicately, the remaining surface more irregularly; epinotal declivity and petiole smooth and shining; postpetiole finely reticulate; summit of the node with delicate transverse rugæ. Gaster smooth and shining, except the basal fourth or third of the first segment, which is sharply longitudinally rugose. Legs shining, coarsely and sparsely punctate.

Body with coarse, yellow, erect hairs, which are especially long and conspicuous on the head, thorax, pedicel and gaster. There are similar but much more reclinate hairs on the legs, antennæ and mandibles.

Ferruginous brown; head and gaster darker, the latter sometimes paler at the base. Legs, and in some specimens also the thorax and pedicel, yellow. Edges of mandibles and anterior border of clypeus black.

Worker. (Plate XLI, Fig. 9). Length 2.3–2.5 mm.

Mandibles slender, with two prominent apical and several minute basal teeth. Head, excluding the mandibles, but little longer than broad, elliptical, without posterior corners. Eyes prominent and convex, in front of the middle of the head. Clypeus convex, with a median keel and an entire, broadly rounded anterior border. Frontal carinæ rather short, high and far apart.

Frontal area depressed, triangular, not fused with the clypeus. Antennæ very slender, scapes, when turned directly back, extending about ⅓ their length beyond the head; all the funicular joints longer than broad; three terminal joints subequal, very long and slender. Thorax resembling that of the soldier, but with rounder and more sloping humeri and no transverse depression on the posterior portion of the pronotum. Mesonotal depression deep and rounded at the bottom. Basal epinotal surface convex, especially in front; spines short, hardly longer than broad at their bases. Petiole like that of the soldier but with a more conical node; postpetiole three times as broad as the petiole, slightly longer than broad, convex above, pyriform, broader behind than in front. Gaster about the size of the head, with a rather straight anterior border. Legs slender.

Smooth and shining; cheeks and front with a few longitudinal rugæ. Meso- and metapleuræ reticulate-rugose, subopaque.

Hairs white or pale yellow, erect or suberect, sparse on the body, more abundant on the legs and antennæ.

Brownish yellow, head and gaster somewhat darker; teeth of mandibles black.

Female (deälated). Length 5.5–6 mm.

Head resembling that of the soldier. Thorax somewhat narrower than the head, longer than broad, with very flat mesonotum and scutellum. Epinotal spines robust, blunt, longer than broad at their bases, more than twice as far apart as long, directed backward and outward and very slightly upward. Petiole from above similar to that of the soldier, broader in front than behind, with sharp anterior corners and straight sides; node much compressed antero-posteriorly so that its summit is a sharp blade, deeply notched in the middle. In profile the anterior slope is long and straight, the posterior short and abrupt. Below, the petiole is produced in the middle into a compressed keel, gradually increasing in height posteriorly. Postpetiole about 2½ times as broad as the petiole, straight and broadest in front, semicircular behind, so that its sides appear to be produced anteriorly as blunt or somewhat truncated projections. In profile the node is high and evenly rounded. Gaster broad and flat.

The sculpture of the head is like that of the soldier. Pro- and mesonotum, paraptera, scutellum and sides of thorax with regular longitudinal rugæ; base of scutellum smooth and shining; petiole and epinotal declivity shining and obscurely punctate-rugulose. Postpetiole subopaque, node transversely rugose. Gaster shining except the basal half of the first segment, which is opaque and covered with regular longitudinal striæ.

Pilosity like that of the soldier.

Deep reddish brown; legs, antennal funiculi and epinotal declivity more yellowish.

Described from several females, soldiers and workers taken by Mr. Hans Sauter from colonies nesting under stones near Okayama, Bizen. The types from Hiogo were very inadequately described by Smith. According to Forel, who received soldiers and workers from Osaka, this species is very closely related to the Indian *Ph. rhombinoda* Mayr, "but the head of the soldier is more elongated, the antennal scrobe shallower, the thorax smoother, the epinotal spines more slender and pointed. In the worker the epinotum is shorter."

9. **Pheidole fervida** *F. Smith.*

Pheidole fervida F. Smith, Trans. Ent. Soc. London, 1874, p. 406, 407, ♃ ☿

Pheidole fervida Mayr, Verhandl. zool. bot. Ges. Wien, XXXVI, 1886, p. 363.

Pheidole fervida Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, pp. 268 and 285, ♃ ☿

A single soldier and six workers taken by Mr. Hans Sauter at Yamanaka, Suruga, and four workers taken by him at Kanagawa, near Yokohama, seem to belong to this species, which was very inadequately described by Smith. As Forel says, it closely resembles *Ph. megacephala*, but the head of the soldier has a faint scrobe for the antennal scape, which is shorter than that of *megacephala*, and the rugæ extend further back. More material of this form is necessary before the status of *Ph. fervida* can be accurately determined. According to Forel living specimens have been imported into Hamburg in bamboo plants.

10. **Monomorium floricola** *Jerdon.*

Monomorium intrudens F. Smith, Trans. Ent. Soc. London, 1874, p. 406. ☿

Monomorium intrudens Mayr, Verhandl. zool. bot. Ges. Wien, XXXVI, 1886, p. 363.

F. Smith's *M. intrudens* may be regarded as a synonym of the well-known tropicopolitan *M. floricola* on the authority of Prof. Emery (*in litteris*) who remarks that Smith's description "agrees in every point" with specimens of the latter species.

11. **Monomorium nipponense** sp. nov.

Worker. Length 1.3 mm.

Head longer than broad, oblong, with parallel sides and straight posterior border. Eyes small, distinctly in front of the middle of the head. Clypeus and frontal area convex, the former with broadly rounded anterior margin. Antennæ 12-jointed, scapes not reaching to the posterior corners of the head; first funicular joint about twice as long as broad, joints 2–8 very small, much broader than long, joints 9 and 10 subequal, as long as broad, together decidedly shorter than the terminal joint. Prothorax half as broad as the head, pro- and mesonotum evenly rounded, hemispherical, separated by a sharp but not very deep constriction from the epinotum which is also evenly rounded and sloping, without any angle between the base and declivity. Petiole barely twice as long as broad, pedunculate in front, broader behind; node in profile high but evenly rounded. Postpetiole no broader than the petiole; globular, but little broader than long; in profile lower than the petiole. Gaster flattened, somewhat larger than the head.

Body smooth and shining throughout.

Hairs yellow, very sparse, erect on the upper surface of the body, delicate and appressed on the antennæ and legs.

Pale yellow; gaster black with a small yellow spot, the size of the postpetiole, at its extreme base.

Described from seven workers taken by Mr. Hans Sauter at Kanagawa near Yokohama. *M. nipponense* is allied to *M. destructor* but differs in its smaller size, much more compact antennæ, shorter and stouter pedicel, proportionally smaller head, etc.

12. **Monomorium triviale** sp. nov.

Worker. Length 1.3–1.5 mm.

Head nearly 1½ times as long as broad, rectangular; occipital border feebly excised. Clypeus broadly rounded in front Eyes in front of the middle of the head. Antennæ 12-jointed; tip of scape reaching about halfway between the eye and the posterior corner of the head; joints 2-8 of the funiculus narrower than the elongated first joint, much broader than long; two basal joints of club subequal, much narrower than the terminal joint and together hardly half as long. Thorax rather slender, anteriorly about half as broad as the head; mesoëpinotal constriction distinct but shallow; epinotum small, rounded, without any angle between the basal and declivous surfaces. Petiole hardly half as broad as the epinotum, nearly twice as long as broad, distinctly pedunculate in front; node in profile high with longer concave anterior and shorter convex posterior slopes. Postpetiole hardly broader than the petiole, a little broader than long, in profile much smaller and lower than the petiole, evenly rounded above. Gaster somewhat smaller than the head. Legs slender.

Surface of body smooth and shining throughout.

Hairs yellow, sparse and erect on the head, thorax and abdomen; shorter and more appressed on the appendages.

Pale yellow throughout; mandibular teeth brownish.

Described from seven workers taken by Mr. Hans Sauter at Kanagawa on a "heath on the margin of a pond."

At first sight this species appears to agree with the Indian *M. atomus* Forel, with which I at first identified it, but Prof. Emery, who has compared some of my specimens with one of Forel's types, writes me that the Japanese insect is smaller, has a narrower head, and shorter antennæ, the scape not reaching so far back and the funiculus being more slender than in *atomus*.

13. **Cremastogaster sordidula** *Nylander* var. **osakensis** *Forel.*

FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 269, ☿

Several workers collected by Mr. Hans Sauter at Kanagawa agree with Forel's description of this yellow form of the palearctic *sordidula*. The types are from Osaka, as the name indicates.

14. **Cremastogaster laboriosa** *F. Smith.*

F. SMITH, Trans. Ent. Soc. London, 1874, p. 407, ☿

The types of this inadequately described species are from Hiogo.

15. **Cremastogaster laboriosa** *F. Smith* var. **matsumurai** *Forel.*

(PLATE XLI, FIG. 1.)

FOREL, Ann. Soc. Ent. Belg., XLV, 1901, p. 372, ☿

Described by Forel from Sapporo in the island of Yezo. It seemed certain to him that his specimens, coming from a locality so far from Hiogo, must represent a distinct variety. I find however that a number of workers collected by Hans Sauter at Kanagawa and Yamanaka agree perfectly with Forel's description of the variety *matsumurai* though these localities are in southern Japan near Hiogo. It is probable, therefore, that the characters which Forel regards as varietal are merely omitted in Smith's brief and slipshod description.

A deälated female from Yamanaka, Suruga, is 6 mm. long, dark brown, with yellowish mandibles, legs and antennæ. Body smooth and shining, very sparsely and finely punctate; anterior half of head subopaque, finely and longitudinally striated. Head broader than long. Epinotal spines very short, stout and blunt. Petiole and postpetiole similar to those of the worker, the latter segment with a faint median depression.

According to a note accompanying the specimens, this ant lives "in small colonies under the bark of pines and Cryptomerias."

16. **Vollenhovia emeryi** sp. nov.

Worker. (Plate XLI, Figs. 10 and 11.) Length 2–2.3 mm.

Head longer than broad, rectangular, with straight, subparallel sides and broadly concave posterior border. Eyes rather large, in front of the middle of the head. Mandibles with 5 graduated teeth. Clypeus short, with transverse anterior border, not produced in the middle, and with two longitudinal, rather thick ridges, diverging anteriorly and separated by a depression. Antennæ 12-jointed; scape short, swollen distally, its tip reaching half the distance between the eye and the posterior corner of the head. Funiculus exceeding the length of the scape by the length of the terminal joint; the three terminal joints forming a distinct club; first funicular joint as long as joints 2–5 together; joints 2–8 broader than long; 9th joint half as long as the 10th, 10th less than half as long as the terminal joint. Prothorax broad in front but distinctly narrower than the head, sides of meso- and epinotum compressed. Dorsal surface of thorax flattened, with a very faint mesoëpinotal depression. Epinotum as high as the mesonotum, with long slanting basal, and much shorter, concave declivous surface and bearing two small teeth widely separated at their bases. Petiole from above 1½ times as long as broad, subrectangular, with sides slightly convex, in profile triangular, with a pointed node, the anterior and posterior declivities of which are subequal, the former slightly concave, the latter nearly straight. The petiole is compressed below and carinate and terminating in a large blunt tooth anteriorly. Postpetiole from above about as long as broad, slightly broader behind than in front, in profile hemispherical above, flattened and toothless below. Gaster long and narrow without basal angles, somewhat flattened dorsoventrally. Legs rather short, femora and tibiæ distinctly thickened.

Mandibles, clypeus, and frontal area shining, the first with scattered punctures. Head subopaque, covered with longitudinal rows of large umbilicate, piligerous punctures or foveolæ, except in the middle where there is a narrow, smooth, shining streak running from the frontal area nearly to the occiput. Thorax and petiole subopaque, pronotum longitudinally rugose and umbilicately punctate; epinotum densely punctate or granular; upper surface of petiole and postpetiole similar to that of the pronotum, the middle of the latter smooth and shining. Gaster and legs shining, with scattered, coarse, piligerous punctures.

Whole body, including legs and antennæ, covered with pale yellow, suberect or reclinate hairs.

Reddish brown; a large elongate spot on the front; the epinotum, upper surface of postpetiole, sides and posterior dorsal surface of gaster blackened. Mandibles, clypeus, antennæ and legs brownish yellow.

Female. Length 3 mm.

Resembling the worker. Mesonotum and scutellum each with a large elongate shining area in the middle, the former also with a shining spot over each parapsis. Postpetiole less shining above in the middle than in the worker. Gaster with large and more numerous piligerous punctures. Wings gray, densely pilose, with brown stigma and veins.

Described from several workers and two females taken by Mr. Hans Sauter at Negishi near Yokohama (Feb. 25, 1905) and numerous workers taken at Yamanaka and Kanagawa. The specimens taken in Kanagawa are marked as taken on a heath.

This species of *Vollenhovia* differs from its Indian and Malayan congeners in its peculiar sculpture and in having a distinctly armed epinotum. In size and general appearance it approaches *V. subtilis* Emery from Papua, but this species has a shining, unarmed epinotum and smoother petiole and postpetiole.

17. **Stenamma owstoni** sp. nov.

Worker. Length 3.25-3.5 mm.

Head, excluding the mandibles longer than broad, sides rather straight, subparallel, posterior corners rounded. Clypeus short, depressed, its anterior border emarginate in the middle, behind fused with the deeply impressed frontal area. Frontal carinæ short, but prominent. Eyes moderate, with 7-8 ommatidia in the longitudinal diameter. Antennal scapes reaching to the posterior corners of the head. Funiculus with a 4-jointed club, first joint twice as long as broad, joints 2-4 nearly as long as broad, 5-7 as long as broad, joints 8-10 slightly longer than broad, terminal joint as long as the two preceding joints together. Thorax with the pro- and mesonotum rather convex, higher than the epinotum and separated from it by a pronounced constriction. Basal epinotal surface in profile straight, longer than the concave declivity; spines small, a little longer than their distance apart at the base, directed upward and backward. Petiole narrow, 3½ times as long as broad, seen from above gradually widening posteriorly, in profile unarmed below, with a very low, rounded node above. Postpetiole 1½ times as broad as the petiole, nearly twice as long as broad, regularly elliptical from above, in profile with a low, regularly rounded node and a slightly concave ventral surface.

Mandibles subopaque, rather coarsely striatopunctate, clypeus and frontal area smooth and shining, head and thorax subopaque, the former rather finely, the latter more coarsely, longitudinally reticulate-rugose. Epinotal declivity smooth and shining. Petiole punctate-rugulose, opaque, except the upper surface of the node which is smooth and somewhat shining. Postpetiole and gaster smooth and shining, the former more opaque and rugose on the sides and below. Legs and antennæ subopaque.

Body and appendages covered with abundant, suberect whitish hairs, which are longest on the gaster.

Reddish brown; head and first gastric segment blackish. Mandibles, clypeus, antennæ and legs, posterior border of first gastric segment and all the remaining segments yellowish.

Described from three specimens collected by Mr. Hans Sauter, at Yamanaka, Suruga, at an altitude of 2000 ft. "in rotten wood." The three specimens appear to have been taken from as many different colonies.

This species is closely related to the European *S. westwoodi* Westw. and the North American *brevicorne* Mayr. From the former it differs in having much larger eyes, longer joints in the base of the antennal funiculus, a lower, less angular and smoother petiolar node, a longer postpetiole and longer and more abundant hairs. From the North American species it differs in these same characters, except that the eyes are of about the same size and the sculpture distinctly finer.

18. **Stenamma (Aphænogaster) famelicum** *F. Smith.*

Ischnomyrmex famelicus F. SMITH, Trans. Ent. Soc. London, 1874, p. 405, ☿

Aphænogaster famelica MAYR, Verhandl. zool. bot. Ges. Wien, Jahrg. 1878, pp. 669, 670, ☿

Aphænogaster famelica FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, pp. 267, 268, ☿

Aphænogaster famelica FOREL, Mitth. naturhist. Mus. Hamb., XVIII, 1901, p. 61.

Of this species, originally described from Hiogo, I find no specimens among my material. Forel records it from Hozuyama, Majori Tamba. The species has been redescribed by Mayr who calls attention to its close resemblance to the nearctic *S.* (*A.*) *fulvum* Roger and the palearctic *striola* Roger.

19. **Stenamma (Messor) aciculatum** *F. Smith.*

Aphænogaster aciculata F. SMITH, Trans. Ent. Soc. London, 1874, p. 405, ☿ ♀

Aphænogaster aciculata MAYR, Verhandl. zool. bot. Ges. Wien, 1878, p. 670.

According to Mayr, who examined one of Smith's type specimens, this species is probably the same as *Aphænogaster obsidiana.* See the following variety.

20. **Stenamma (Messor) aciculatum** *F. Smith* var. **brunneicorne** *Forel.*

(PLATE XLI, Fig. 14.)

FOREL, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, pp. 60, 61, ☿

Forel described this form, which he somewhat doubtfully referred to Smith's *A. aciculata*, from Hozuyama, Kuwadagori Tamba. Among my material I find three workers taken from as many colonies at Takakiyama near Kanagawa by Mr. Hans Sauter. They agree very well with Forel's description, except that all the funicular joints are longer than broad, a character which brings them closer to the well-known *S.* (*M.*) *barbarum.* Forel notes the resemblance of the Japanese form to *S. barbarum* var. *rugosum.* It is not improbable that more material may lead us to change the name of the form to *S.* (*M.*) *barbarum* var. *aciculatum.*

21. **Myrmica rubra lævinodis** *Nylander.*

Forel (Ann. Soc. Ent. Belg., XLV, 1901, p. 371) mentions a female of this subspecies from Sapporo, Yezo, as being "absolument typique."

22. **Myrmica rubra lobicornis** *Nylander* var. **jessensis** *Forel.*

Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 371, ☿

According to Forel, the worker of this variety has "the antennal lobe a little shorter than the type, the epinotal spines shorter and the petiolar node more rounded, almost as in the var. *schencki* Emery, so that I cannot decide, notwithstanding the characters of the male, to assign it to *scabrinodis*. It has the deep color of the *lobicornis* of the northern Alps. Its antennal lobe is much more developed than in the variety *fracticornis* Emery of the United States."

It is a significant fact that none of the forms of the circumpolar *M. rubra* are represented in Mr. Sauter's collections from southern Japan.

23. **Leptothorax congruus** *F. Smith.*

F. Smith, Trans. Ent. Soc. London, 1874, p. 406, ☿

Worker. Length 2–2.5 mm.

Head, excluding the mandibles, longer than broad, with slightly convex sides and straight posterior margin. Eyes a little in front of the middle. Clypeus convex with nearly straight anterior border, without a median depression or emargination. Antennæ 12-jointed; tip of scape not reaching the posterior corner of the head by a distance equal to its transverse diameter; first funicular joint 3 times as long as broad, joints 2–8 distinctly broader than long, subequal, joints 9–11 forming a club, the terminal joint of which is as long as the two preceding subequal joints together. Thorax in front nearly two-thirds as broad as the head, with rounded and sloping humeri, in profile straight above, with barely indicated mesoëpinotal constriction. Epinotal spines short, acute, about a third the length of the straight basal surface, a little further apart at their bases than long, directed outward, backward and a little upward. Petiole from above nearly half as broad as the epinotum, more than twice as long as broad, gradually widening anteriorly; in profile with a well developed node, whose anterior slope is slightly concave and hardly longer than the convex posterior slope. Postpetiole from above 1½ times as broad as the petiole, a little broader than long, rectangular, in profile convex dorsally, especially in front. Gaster flattened dorsoventrally, with straight anterior border. Legs rather robust, femora incrassated in the middle.

Mandibles coarsely striato-punctate. Clypeus longitudinally rugose, smoother and more shining in the middle. Head, thorax and pedicel subopaque; head rather finely and longitudinally rugose-punctate; thorax irregularly and coarsely rugose on the dorsal surface, pleuræ and epinotum more finely and reticulately rugose, as are also the petiole and postpetiole. Gaster smooth and shining.

Hairs white, obtuse, erect and rather short on the trunk; delicate, tapering and appressed on the appendages.

Dark brown; head and gaster nearly black; mandibles, legs and antennæ yellowish brown; antennal scapes and clubs, middle portions of femora and tibiæ darker and in some specimens almost black

Female (deälated). Length 3–3.75 mm.

Resembling the worker. The thorax is robust, flattened and rather shining above; the mesonotum and scutellum regularly longitudinally rugose, the latter smoother behind. Epinotum and pedicel opaque, very coarsely rugose; epinotal spines short and blunt. Color like that of the worker except that the thorax is almost black.

Described from three females and numerous workers collected by Mr. Hans Sauter at Takakiyama, Kanagawa and Yamanaka, Suruga. F. Smith's types of this species were from Hiogo.

24. **Leptothorax congruus** *F. Smith* var. **spinosior** *Forel.*

Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 371, ☿

According to Forel this variety, of which he obtained specimens from Sapporo, Yezo, has the epinotal spines "long and curved inward, as long as the basal epinotal surface and longer than their interval, reddish at their tips." Four workers and a deälated female collected by Hans Sauter at Yamanaka at an altitude of 900 ft. agree with Forel's description. They are all smaller and much paler in coloration than the corresponding phases of the typical *congruus* above described The epinotal spines diverge but are bent downwards at their tips. Forel calls attention to the similarity of this variety to the European *L. tuberum* Fabr.

25. **Tetramorium cæspitum** *Linn.*

Forel (Bull. Soc. Ent. Suisse, X, 7, 1900, p. 268) mentions two varieties of this common European ant from Osaka, "one paler and smaller, the other black and larger." Among my specimens two workers collected by Professor J. F. Abbott near the Marine Biological Laboratory at Misaki belong to the large, dark form. Six others collected by Mr. Hans Sauter at Kanagawa are decidedly smaller but of the same dark color.

26. **Pristomyrmex japonicus** *Forel.*

(Plate XLI, Fig. 7.)

Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, pp. 268, 269, ☿
Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 371.

The types of this species are from Osaka, but Forel mentions its occurrence also at Sapporo, Yezo. Twelve workers collected by Professor J. F. Abbott near the Marine Biological Laboratory at

Misaki agree well with Forel's description. The long epinotal spines are distinctly divergent and the funicular joints 2–7 are broader than long. These characters serve to distinguish the species from the closely allied *P. pungens* Mayr of Ceylon and Malacca.

27. **Strumigenys godeffroyi** *Mayr* var. **lewisi** *Cameron.*

Strumigenys lewisi CAMERON, Proceed. Manchester Lit. Phil. Soc., XXV, 1886, pp. 229, 230, ☿ ♀

Strumigenys godeffroyi MAYR var. *lewisi* MAYR, Verhandl. zool. bot. Ges. Wien, XXXVII, 1887, p. 569, *nota*, ☿ ♀

Strumigenys godeffroyi MAYR var. *lewisi* MAYR, Termeszétrajzi Füzetek, XX, 1897, pp. 431, 432 (pseudogyne?).

Strumigenys godeffroyi var. *lewisi* FOREL, Journ. Bombay Nat. Hist. Soc., XIV, 1902, p. 707.

Strumigenys lewisi BINGHAM, Fauna Brit. India, Hymenopt, II, 1903, p. 149, ☿

This ant (Plate XLI, Fig. 12), which is known to occur also in Burma and Ceylon, was originally described by Cameron from Nagasaki. Later Mayr showed that it is hardly more than a variety of the Samoan *S. godeffroyi*, from which it differs in having curved instead of straight mandibular blades. I have before me a number of workers and a few deälated females collected by Mr. Hans Sauter in the following localities: Negishi, Kanagawa and Yamanaka (1700 ft.). According to a note accompanying the specimens they were taken "in siftings in pine woods."

Subfamily DOLICHODERINÆ.

28. **Iridomyrmex itoi** *Forel.*

FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 269, ☿

I have not seen the typical form of this species, which is allied to the Australian and Indian *I. glaber* Mayr. It differs mainly in the structure of the epinotum, the basal surface of which "is much longer than in *glaber*, nearly twice as long as broad, with a transverse impression which makes it appear a little concave in profile. The declivous surface is more inclined than in *glaber;* it is not longer than the basal surface nor overhung by its posterior edge." The types are from Osaka.

29. **Iridomyrmex itoi abbotti** var. nov.

Worker. (Plate XLI, Fig. 3.) Length 1.75–2.25 mm.

Head, excluding the mandibles, a little longer than broad, with straight posterior and rather convex lateral borders. Clypeus rather convex in the middle behind, flattened laterally, with a pronounced median excision in its anterior border. Eyes a little in front of the middle of the head. Frontal area distinct, triangular; frontal groove tenuous but distinct, not interrupted in the middle. Antennal scapes reaching to the posterior corners of the head. Thorax in profile with perfectly straight dorsal surface, interrupted by a deep but narrow mesoëpinotal depression. Basal surface of epinotum flat, decidedly shorter than the declivity which is concave and separated from the base by a sharp angle. Petiole vertical, as high and as broad as the epinotum, much compressed anteroposteriorly, somewhat thinner below than above, slightly flatter behind than in front; edge sharp, broadly and evenly rounded when seen from behind.

Mandibles shining, very finely striated, and coarsely and sparsely punctate. Whole body shining, distinctly reticulate, except the gaster which is very glabrous.

Hairs white, erect and much scattered on the vertex, gaster and mandibles. Legs and antennæ with sparse white pubescence.

Black; mandibles dark brown, legs dark brown or black, with yellow knees and tarsi; antennæ yellow with the tips of the scapes and the funiculi brown or blackish. Gaster with metallic violet reflections. In some specimens, possibly immature, the head and thorax are dark brown.

Described from numerous specimens collected by Professor J. F. Abbott at Itajima Aki.

I was at first inclined to regard this variety as a distinct species but Prof. Emery informs me that *abbotti* differs from the typical *itoi* only in the metallic violet color of the gaster.

30. **Technomyrmex gibbosus** sp. nov.

Worker. (Plate XLI, Fig. 4.) Length 2–2.5 mm.

Mandibles rather large, with straight multidenticulate blades. Head longer than broad; posterior border straight; sides rather convex. Clypeus convex, with a deep notch in the middle of its anterior border. Eyes large, flattened, in front of the middle of the head. Antennal scapes reaching a little beyond the posterior corners of the head; second funicular joint twice as long as broad, remaining joints, except the terminal, hardly longer than broad. Clypeal and antennal foveæ confluent. Frontal area obsolescent, frontal groove lacking. Thorax in front $\frac{2}{3}$ as broad as the head; pronotum broader than long; mesonotum as long as broad, mesoëpinotal constriction deep. Epinotum with very convex basal surface, which forms a right angle with the posterior slope of the mesonotum, and passes over into the declivity through a rounded angle; declivity twice as long as the base, flattened above and somewhat concave below. Petiole almost without a trace of a node, elliptical from above, about twice as long as broad. Gaster rather narrow, pointed behind, with a slit-shaped anus.

Mandibles lustrous or shining, faintly and sparsely punctate. Head and thorax opaque, finely and densely punctate or reticulate, the declivity of the epinotum in some specimens more shining. Gaster smooth and shining. Legs and antennæ subopaque like the head and thorax.

Hairs yellowish, inconspicuous, absent except on the mandibles. Pubescence whitish, very short and sparse, most distinct on the gaster and appendages.

Dull yellowish brown, gaster somewhat darker, mandibles, antennæ and legs yellow; femora and scapes brownish.

Described from numerous specimens collected by Mr. Hans Sauter at Yamanaka, Suruga ("1100 ft., sifted in deciduous forests"); Kanagawa and Takakiyama.

This species which at first sight resembles a pale *Tapinoma erraticum* or *T. sessile* is closely related to *Technomyrmex albipes* It differs in its lighter color and the more gibbous structure of the epinotum as I find by comparison with specimens of that species from India and Madagascar. In these same characters and its smaller size *T. gibbosus* differs from *T. mayri* Forel of Madagascar. It differs from *T. grandis* Emery of Sumatra in lacking the erect hairs on the legs and antennal scapes and from *T. strenuus* Mayr of Borneo and Singapore in lacking the long hairs on the gaster, though it seems to resemble this species in the shape of the epinotum. Finally from *T. modigliani* Emery of Sumatra, the Japanese species may be readily distinguished by its much narrower head, feebler clypeal notch, shorter funicular joints, etc.

Subfamily CAMPONOTINÆ.

31. **Prenolepis flavipes** (*F. Smith*) *Mayr.*

Tapinoma flavipes F. SMITH, Trans. Ent. Soc. London, 1874, p. 404, ☿ ♀

Prenolepis flavipes MAYR, Verhandl. zool. bot. Ges. Wien, XXXVI, 1886, p. 363.

Prenolepis flavipes FOREL, Ann. Soc. Ent. Belg., XLV, 1901, p. 371.

Prenolepis flavipes FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, pp. 269, 270, ☿ ♀ ♂

Worker. Length 1.5–1.7 mm.

Mandibles 6-toothed. Head distinctly longer than broad, with rounded posterior angles. Clypeus convex, barely carinate, its anterior border deeply and rather broadly excised in the middle. Antennal scapes projecting for fully $\frac{2}{5}$ of their length beyond the posterior corners of the head; funicular joints all longer than broad. Pronotum broader than long; mesoëpinotal depression pronounced, flat at the bottom, longer than the transverse diameter between the two stigmata. Epinotum with a short convex basal surface, passing insensibly into the longer and flatter declivity. Petiole low, in profile with convex ventral border and node inclined forward, the latter with both its anterior and posterior slopes slightly convex; edge viewed from behind straight.

Whole body smooth and shining; mandibles finely striated.

Hairs yellow; long, erect and tapering on the body; shorter and suberect on the legs and antennal scapes. Pubescence grayish, distinct on the head, antennæ and legs, but almost imperceptible on the remainder of the body.

Body and appendages yellow; clypeus, upper surface of head and gaster dark brown. Mandibular teeth black.

Female. Length 4.5–5 mm.

Dark brown; mandibles, mouthparts, antennæ and legs yellow; mandibular teeth black. Wings uniformly brownish, with brown veins. Surface of body finely shagreened but shining, covered with long grayish pubescence, as are also the legs and antennæ. Hairs sparse, yellowish, erect, like those of the worker.

Male. Length 1.5–1.6 mm.

Resembling the worker in size and coloration, except that the thorax is dark brown like the head and gaster. Mandibles, legs, antennæ and genital valves slightly infuscated. Surface of the head, thorax and gaster very glabrous. Wings like those of the female. For the conformation of the genital valves see Fig. 1, *a–c*. Erect hairs on the body similar to those of the worker but shorter, absent on the antennal scapes and very sparse on the legs. Pubescence almost imperceptible except on the legs.

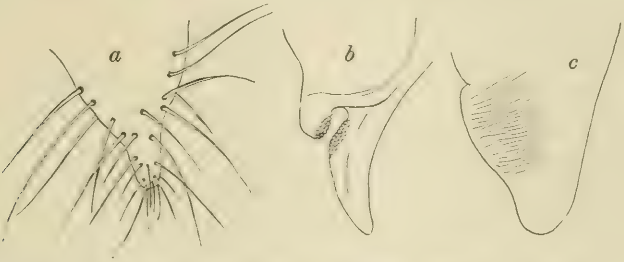


Fig. 1. *Prenolepis flavipes* (F. Smith), Mayr. Male. *a*, outer; *b*, median; and *c*, inner genital valve.

The types of this species are from Hiogo. Forel obtained workers from Osaka, and all three phases imported from Japan into Hamburg with plants. I have before me a large number of specimens of all three phases collected by Professor J. F. Abbott near the Marine Biological Laboratory at Misaki, and by Mr. Hans Sauter in the following localities: Kanagawa ("under bark at edge of pond"), Yamanaka ("sifted in deciduous and pine woods"), Negishi, Takakiyama and Okayama. There are several males from Okayama taken May 21, '05 and winged females from Kanagawa taken April 8, '05.

32. **Lasius niger** *Linn.*

F. Smith, Trans. Ent. Soc. London, 1874, p. 403.
Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 269, ☿
Forel, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 66.

Numerous workers and a few deälated females of this well-known ant were collected by Professor J. F. Abbott near the Marine Biological Laboratory at Misaki, and by Mr. Hans Sauter in the following localities: Yamanaka, Suruga (1300, 1700 and 2000 ft.; "in rotten wood and under oak bark"), Kanagawa ("pine woods, on heaths, and along the edges of brooks") and Takakiyama. These specimens all closely resemble the typical European *niger*, in size, coloration and the hairiness of the legs and antennæ. Forel had specimens from Yezo and Osaka.

33. **Lasius niger** *Linn.* var. **alienus** *Förster.*

Ern. André, Bull. Mus. d' Hist. Nat. Paris, 1903, p. 128, ☿ ♀

A single worker of this variety was found among the material collected by Mr. Hans Sauter at Kanagawa.

34. **Lasius niger brunneus** *Latreille.*

Lasius brunneus Forel, Mitth. naturhist. Mus. Hamburg, XVIII, 1901, p. 66.

Recorded by Forel from Yokohama.

35. **Lasius umbratus** *Nylander.*

Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 269 ☿
Forel, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 66.

A single winged female taken during July, 1901, by Mr. Hans Sauter at Okayama. The species is also recorded from Osaka by Forel.

36. **Lasius flavus myops** *Forel.*

A single worker taken by Mr. Hans Sauter at Kanagawa agrees very closely with typical specimens of this subspecies from Terni

37. **Lasius fuliginosus** *Latreille.*

F. Smith, Trans. Ent. Soc. London, 1874, p. 403.

A number of workers and males collected by Mr. Hans Sauter at Kanagawa (July 2, '05) "under the bark of an oak tree" are indistinguishable from European specimens.

38. **Formica sanguinea** *Latreille.*

Ern. André, Bull. Mus. d' Hist. Nat. Paris, 1903, p. 128, ♀

Possibly the female of the following variety, which was described from worker specimens only.

39. **Formica sanguinea** *Latreille* var. **fusciceps** *Emery.*

Emery, Zool. Jahrb., Abth. f. Syst., VIII, 1894, p. 335, *nota*, ☿

Emery's description of this variety, based on three workers from Yokohama, shows it to be closely related to the North American *F. sanguinea aserva* Forel, which is also characterized by the dark color of the head.

40. **Formica rufa pratensis** *DeGeer.*

Formica pratensis FOREL, Ann. Mus. Zool. Acad. Impér. Sc. St. Pétersb. VIII, 1903, p. 18, ♀

Forel records a female of this palearctic subspecies of *F. rufa* L. from the island of Sakhalin. It will probably be found also in the northern portion of Japan or at high altitudes.

41. **Formica rufa truncicola** *Nylander.*

Formica truncicola FOREL, Ann. Mus. Zool. Acad. Impér. Sc. St. Pétersb., VIII, 1903, p. 18, ♀

Formica rufa r. *truncicola* ERN. ANDRÉ, Bull. Mus. d' Hist. Nat. Paris, 1903, p. 128, ♀

Forel has also recorded a female of this subspecies from the Island of Sakhalin. Ern. André mentions a specimen of the same sex from Japan.

42. **Formica rufa truncicola** *Nylander* var. **yessensis** *Forel.*

FOREL, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 66, ☿

This variety, according to Forel, "is distinguished from the typical *truncicola* by its sparser erect hairs, which are very sparse on the antennal scapes and completely lacking on the extensor surface of the tibiæ; only on their lower surfaces are there any of the oblique, stouter hairs. The basal surface of the epinotum is also somewhat shorter and more convex." The types of this apparently northern form were collected in Serachi, province Ishikari, Yezo.

43. **Formica fusca** *Linn.* var. **nipponensis** *Forel.*

FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 270, ☿

FOREL, Mitth. naturhist. Mus. Hamburg, XVIII, 1901, p. 66, ♀

ERN. ANDRÉ, Bull. Mus. d' Hist. Natur. Paris, 1903, p. 128.

Numerous workers collected by Professor J. F. Abbott near the Marine Biological Laboratory at Misaki and by Mr. Hans Sauter at Kanagawa (1700 ft.; "nest in ground on border of pond") and Takakiyama. Forel's specimens were from the island of Yezo and from Tokio.

The head and thorax of this variety resemble in their lustre the corresponding parts of the European *fusca* and the North American var. *subsericea*, but, as Forel has remarked, the gaster is much more opaque than in either of these forms. The legs and antennæ are redder than in the typical *subsericea*.

44. **Camponotus herculeanus japonicus** *Mayr.*

Camponotus japonicus Mayr, Verhandl. zool. bot. Ges. Wien, XVI, 1866, p. 885, ☿

Camponotus japonicus F. Smith, Trans. Ent. Soc. London, 1874, p. 403, ☿

Camponotus herculeanus r. *pennsylvanicus* var. *japonicus* Forel, Bull. Soc. Vaud. Sc. Nat., XVI, 1879, p. 56, ☿ ♀ ♂

Camponotus pennsylvanicus var. *japonicus* Emery, Ann. Soc. Ent. France, 1893, p. 268.

Camponotus japonicus Ern. André, Bull. Mus. d' Hist. Nat. Paris, 1903, p. 128, ☿

Camponotus pennsylvanicus var. *japonicus* Forel, Ann. Mus. Zool. Acad. Impér. Sc. St. Pétersb., VIII, 1903, p. 380, ☿ ♂

Camponotus japonicus Bingham, Fauna Brit. Ind., Hymenopt., II, 1903, p. 370, 371, fig. 117, ☿

This ant is represented in my collection by a number of workers, soldiers and females (one winged) collected by Mr. Hans Sauter at Kanagawa, Takakiyama and Bukenji near Yokohama; several soldiers and workers collected by Professor J. F. Abbott near the Marine Biological Laboratory at Misaki; one deälated female, two soldiers and two mediæ marked "Japan" (Coll. Am. Mus. Nat. Hist.) and a soldier and worker from Chemulpo, Corea (Coll. Phila. Acad. Sci.).

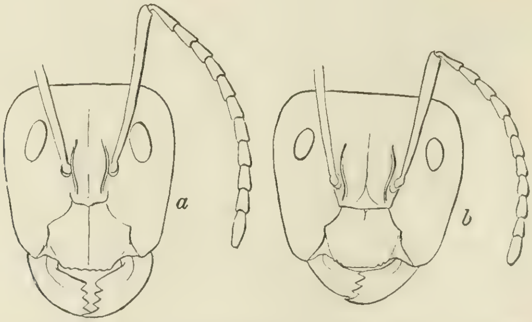


Fig. 2. *a*, Head of worker major of *Camponotus herculeanus japonicus* Mayr; *b*, head of worker major of *C. h. pennsylvanicus* De Geer.

Comparison of these specimens with a long series of our North American *C. herculeanus pennsylvanicus* convinces me that the Japanese form should rank as an independent subspecies. Not only is the clypeus of the soldier longer and more projecting, and the anterior border of the head red, as Forel has pointed out, but the head is narrower and has more flattened sides than in the American form (see Fig. 2*a* and *b*). The types of *japonicus* are in the Leyden Museum.

Forel has seen specimens from Osaka and also from southern Ussuri, Sidemi, Western China. Bingham has recorded it from the Karen and Shan Hills, Burma. Emery has noted its occurrence in the Philippines (Mindanao). He has also described two very similar Asiatic varieties of *herculeanus*, namely *punctatissimus* from Burma (Carin Cheba, 900–1100 m.) and *aterrimus* from Eastern Siberia. It may be admissible to attach these to the subspecies *japonicus*, which would then include all the East Asiatic *herculeanus*,—even the variety *sachalinensis* Forel (*vide infra*),—excepting the forms that are referable to the subspecies *ligniperdus*.

45. **Camponotus herculeanus** *Linn.* var. **sachalinensis** *Forel.*

Forel, Ann. Mus. Zool. Acad. Impér. Sc. St. Pétersb., VIII, 1903, p. 14, ♀

Based on female specimens only, collected in Mongolia, Manchuria and Sakhalin. According to Forel, this variety "differs from the typical *herculeanus* in its entirely black color (mandibles included) and its feeble sculpture, which renders it smooth and more shining. The pubescence on the gaster is also shorter and sparser. These last characters ally this variety with *ligniperdus*, from which it differs however in color and the more thickset stature which is identical with that of *herculeanus*. The wings are exactly like those of the typical *herculeanus* and very different from those of *ligniperdus* and *vagus*. The sculpture and pilosity separate this variety completely from *pennsylvanicus* and *vagus*."

46. **Camponotus herculeanus ligniperdus** *Latreille* var. **obscuripes** *Mayr.*

Camponotus ligniperdus var. *obscuripes* Mayr, Verhandl. zool. bot. Ges. Wien, XXVIII, 1878, p. 645, ☿

Camponotus ligniperdus var. *obscuripes* Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 270.

Camponotus ligniperdus var. *obscuripes* Forel, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 70.

Camponotus ligniperdus var. *obscuripes* Ern. André, Bull. Mus. d'Hist. Natur. Paris, 1903, p. 128, ♀♂

Of this variety, which is not represented in the material collected by Mr. Hans Sauter and Professor J. F. Abbott, Forel examined specimens from Osaka.

47. **Camponotus marginatus vitiosus** *F. Smith.*

Camponotus vitiosus F. Smith, Trans. Ent. Soc. London, 1874, p. 403, ☿

Camponotus marginatus Mayr, Verhandl. zool. bot. Ges. Wien, 1878, pp. 645, 646.

Camponotus marginatus subsp. *vitiosus* Emery, Zool., Jahrb. Abth. f. Syst., VII, 1893, p. 675, *nota.*

Camponotus marginatus race *vitiosus* Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 270.

Worker major. Length 5–5.5 mm.

Mandibles, clypeus and anterior ⅔ of head subopaque, finely and densely punctate and in addition with shallow, scattered foveolæ. Remainder of body shining, thorax sharply, occiput and gaster much more finely and indistinctly shagreened.

Hairs pale yellow, erect, obtuse and abundant on the mandibles, cheeks and front; longer on the thorax and edge of petiole; sparse and rather inconspicuous on the gaster.

Black; mandibles, anterior third of head, antennæ and legs deep red or brown; in some specimens the trochanters, tips of the coxæ and lower portion of the petiole are yellow; tips of antennæ infuscated.

Worker minor. Length 3.5–4.5 mm.

Resembling the worker major except that the anterior portion of the head is not foveolate, the legs are more yellow and the hairs on the cheeks are less numerous and mostly appressed.

Described from numerous workers taken by Mr. Hans Sauter at Kanagawa from a single colony nesting "in an old oak."

While the above described form is certainly a variety or subspecies of the well-known palearctic and nearctic *marginatus*, I am unable to state positively that it is the true *vitiosus* of F. Smith. None of the authors mentioned in the above synonymy has given a careful description of *vitiosus*, and it is not improbable that *marginatus* is represented in Japan by several undescribed varieties.

48. **Camponotus marginatus** *Latreille* var. **quadrinotatus** *Forel.*

Forel, Ann. Soc. Ent. Belg., XXX, 1886, p. 142, ☿ ♀

Forel, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 270.

The types of this beautiful variety are in the Berlin Museum. I have examined a single worker media collected by Mr. Hans Sauter at Kanagawa, and a winged female, male, two major workers and a worker minor collected by Professor Mitsukuri, probably near Tokio, and kindly sent me by Dr. William H. Ashmead. As Forel has shown, the worker major differs from that of the typical European form in having a proportionally larger head. The two ivory yellow spots on the first gastric segment are sometimes confluent. The hitherto undescribed male is deep black, without a trace of spots on the gaster. At first sight one would be inclined to regard this form as more than a mere variety of *marginatus*, but closer examination shows that the only important character is the maculation of the gaster in the females and workers, and large series of specimens will undoubtedly show that this character is highly variable. Similar conditions are seen in the American *C. landolti* and in *C. quadrimaculatus* of Madagascar. Both of these species show all gradations between a beautiful development of gastric spots and their complete absence. A somewhat similar condition is seen also in the American *C. ruficeps.*

49. **Camponotus marginatus brunni** *Forel.*

FOREL, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 70, ☿

Forel based this subspecies on the worker minor obtained from Hozuyama. It resembles the variety *quadrinotatus* but lacks the white spots on the gaster and has a blunt petiole.

50. **Camponotus (Colobopsis) rothneyi** *Forel.*

Camponotus (Colobopsis) rothneyi FOREL, Journ. Bombay Nat. Hist. Soc., VII, 1893, p. 435, ☿ ♀

Colobopsis rothneyi BINGHAM, Fauna. Brit. India, Hymenopt., II, 1903, p. 346.

A single soldier and deälated female, agreeing very closely with Forel's description of this species, were taken by Mr. Hans Sauter at Okayama. There are no pale spots on the gaster as in the European *C. truncatus*, of which it may be merely a subspecies. Forel has described from Singapore a form which he calls *C. rothneyi* r. *krafti.*

51. **Polyrhachis lamellidens** *F. Smith.*

F. SMITH, Trans. Ent. Soc. London, 1874, pp. 403, 404, ☿
MAYR, Verhandl. zool. bot. Ges. Wien, 1878, p. 652, ☿
FOREL, Bull. Soc. Ent. Suisse, X, 7, 1900, p. 270.
FOREL, Mittheil. naturhist. Mus. Hamburg, XVIII, 1901, p. 78.
BINGHAM, Fauna Brit. India, Hymenopt., II, 1903, p. 403, fig. 139, ☿

Worker. (Plate XLI, Fig. 2.) Length 6–6.5 mm.

Mandibles with 4 subequal teeth. Clypeus convex, anteriorly subcarinate. Head convex above, excluding the mandibles about as broad as long, with rounded sides and occipital border. Thorax with steep, flattened, lateral and concave dorsal surfaces, meeting on each side in a prominent ridge, which is sharply interrupted at the pronounced promesonotal and mesoëpinotal sutures. Pronotum about as broad as long, its lateral ridge continued anteriorly on each side into a long spine, which is directed outward and forward and curved downward at its tip. Mesonotum broader than long, bearing at the middle of each side a rapidly tapering spine about half as long as those of the pronotum, and curved upward, outward and especially backward. Basal surface of epinotum 1½ times as long as broad, terminating behind in a pair of very blunt flat spines, which are directed backward and somewhat outward and upward. The ridge along the side of the basal surface is sometimes crenate or serrate and is always continued down along the side of the declivity, which is very sloping and about as long as the basal surface. Petiole seen from above as long as broad, very thick above where it bears a pair of long, somewhat flattened, hook-shaped spines, which diverge laterally and somewhat posteriorly from their very insertions. Gaster spherical.

Head, legs and gaster shining, finely shagreened. Mandibles finely striated. Thorax and petiole opaque, punctate-rugulose, the dorsal surface of the former more uniformly punctate. Upper anterior surface of the petiole very finely and transversely rugulose.

Mandibles, legs and occiput with sparse, suberect grayish hairs. Pubescence pale, very sparse on the head, legs and gaster; more abundant, but by no means concealing the sculpture, on the pleuræ and base of the gaster.

Thorax and petiole dark red, tips of thoracic and petiolar spines and remainder of the body deep black.

Several workers taken by Mr. Hans Sauter at Okayama. Smith's types and the specimens studied by Forel were from Hiogo. Smith mentions the species as occurring also in Hong-Kong. Bingham has described a closely related species, *P. craddocki* from India. In this species the pronotal spines do not point downward, the mesonotal spines are nearly vertical and the petiole is "surmounted by two cylindrical spines which rise vertically and are close together and parallel for three-fourths of their length from the base." In *P. lamellidens* the petiolar spines diverge from their very bases.

EXPLANATION OF PLATE XLI.

Fig. 1. *Cremastogaster laboriosa* F. Smith var. *matsumurai* Forel. Worke,

Fig. 2. *Polyrhachis lamellidens* F. Smith. Worker.

Fig. 3. *Iridomyrmex itoi* Forel var. *abbotti* var. nov. Worker.

Fig. 4. *Technomyrmex gibbosus* sp. nov. Worker.

Fig. 5. *Sysphincta watasei* sp. nov. Worker.

Fig. 6. *Pachycondyla* (*Pseudoponera*) *sauteri* sp. nov. Worker. Fig. 6*a* antennal funiculus of same.

Fig. 7. *Pristomyrmex japonicus* Forel. Worker.

Fig. 8. *Pheidole nodus* F. Smith. Soldier.

Fig. 9. *Pheidole nodus* F. Smith. Worker.

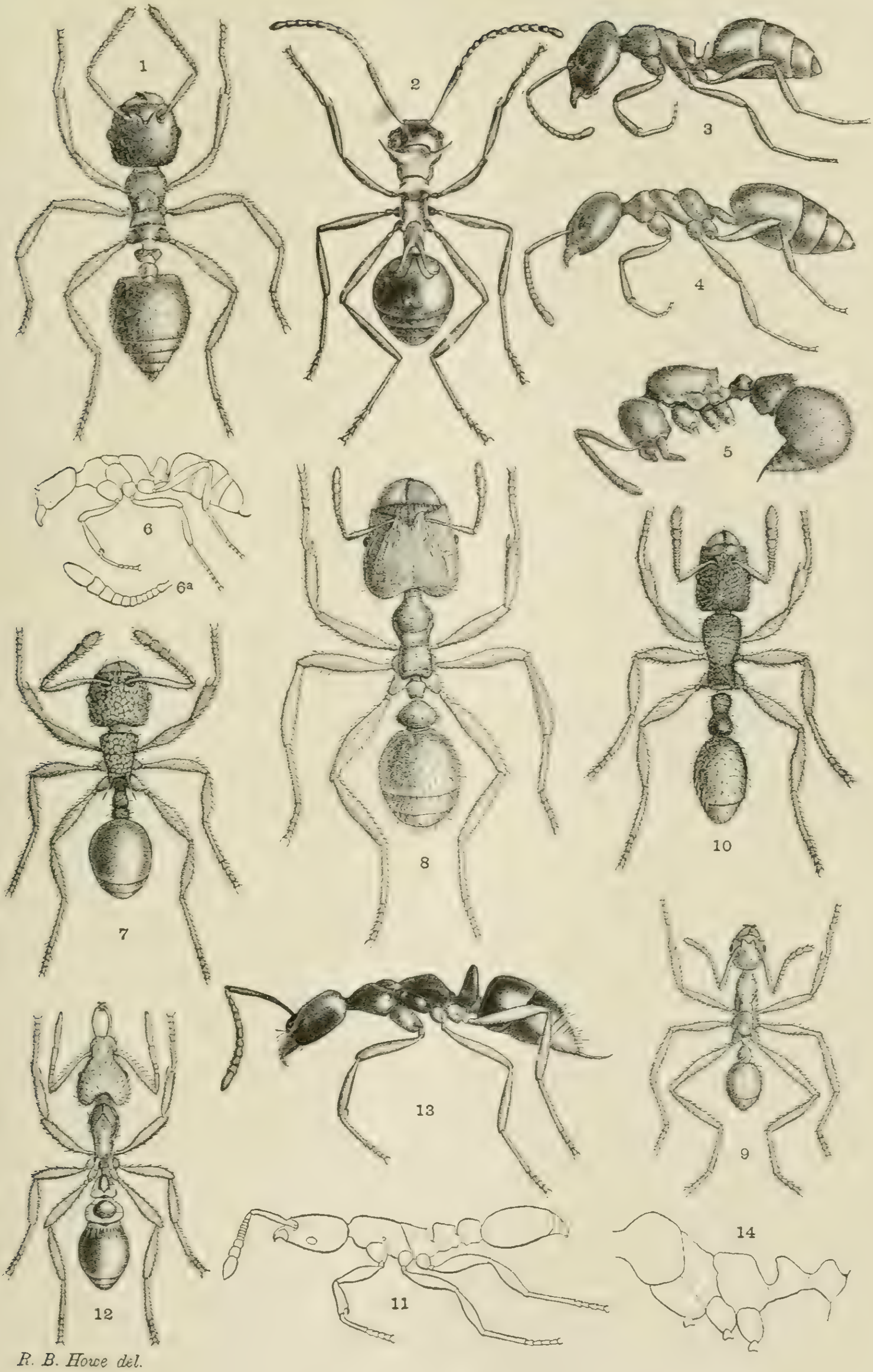
Fig. 10. *Vollenhovia emeryi* sp. nov. Worker.

Fig. 11. *Vollenhovia emeryi* sp. nov. Worker, in profile.

Fig. 12. *Strumigenys godeffroyi* Mayr var. *lewisi* Cameron. Worker.

Fig. 13. *Euponera* (*Brachyponera*) *solitaria* F. Smith. Worker.

Fig. 14. *Stenamma* (*Messor*) *aciculatum* F. Smith var. *brunneicorne* Forel. Thorax and pedicel of worker in profile.


1
2
3
4
5
6
6a
7
8
10
9
13
12
11
14

R. B. Howe del.

Japanese Ants.

59.57,96(79.1)

Article XIX.—THE ANTS OF THE GRAND CAÑON.

By William Morton Wheeler.

During the spring of 1905 Dr. B. E. Dahlgren and myself visited several localities in New Mexico and Arizona for the purpose of collecting and studying the desert invertebrates and certain plants to be used in the construction of some of the large vertebrate groups in the American Museum of Natural History. While on this expedition we made an excursion to the Grand Cañon and spent three days (May 25 to 27) in a study of its fauna and flora, so far as these were accessible from the Bright Angel Trail. Special attention was given to the Formicidæ as a group of insects of more than ordinary interest from the standpoint of geographical distribution. I therefore collected all the species I could find from the Kohonino Forest on the rim of the cañon down to the bed of the Colorado River, 5000 feet below, noting the altitude and environment of each colony, so far as this was possible in the brief time at my disposal. The first day was spent in the great pine forest on the rim, the second was devoted to the Bright Angel Trail, and the third to the Indian Garden and the adjoining Angel Plateau.

Of the few naturalists who have visited the Grand Cañon for the purpose of studying the geographical distribution of its animals and plants, I may mention Merriam and Coville and McDougal. In his valuable paper on the biological survey of the San Francisco Mountains and the adjacent Desert of the Little Colorado[1] Merriam includes a brief but excellent account of the vertebrates and more conspicuous plants, with a list of 21 species of mammals and 57 species of birds taken on the southern wall from the rim to the bottom of the Grand Cañon. His conclusions are summed up in the following paragraph:

"In descending from the plateau level to the bottom of the cañon a succession of temperature zones is encountered equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico.[2] They result from the combined effects of altitude and slope-exposure, the effects of the latter being here manifested in an unusual degree. Where the walls of the cañon face north or north east the uppermost tree-zone consists of Douglas and balsam firs (*Pseudotsuga douglasii* and *Abies concolor*)—northern species which do not occur elsewhere in the cañon. Below this is a belt of pines (*Pinus ponderosa*), succeeded in turn by a belt of junipers [*Juniperus occidentalis monosperma*] and piñon [*Pinus edulis*], usually more or less mingled with pines. Immediately below the piñon belt is a zone which corresponds in the main to the Desert of the Little Colorado; but since it has humid as well as arid areas, forms of vegetation unknown on the desert interrupt its stretches of cactuses, yuccas, and greasewoods. Still lower down another zone is encountered which may be recognized by the presence of huge cactuses, arborescent opuntias, agaves whose tall stems are conspicuous land-marks, and many of the plants characteristic of the Lower Colorado and Gila regions, together with subtropical humid forms and a certain percentage of species not found elsewhere. The complex and interacting effects of radiation and refraction, of aridity and humidity, of marked differences in temperature at places of equal altitude on opposite sides of the cañon, of every possible angle of slope-exposure, and of exposure to and protection from winds and storms, produce a diversity of climatic conditions the effect of which on the animal and vegetable life of the cañon has been to bring into close proximity species characteristic of widely separated regions, and to crowd the several life zones into narrow parallel bands along the sides of the cañon—bands which expand and contract in conforming with the ever-changing surface. The same conditions modify and alter the species there present in the manner in which the evolution of new species is brought about. In short, the Grand Cañon of the Colorado is a world in itself, and a great fund of knowledge is in store for the philosophic biologist whose privilege it is to study exhaustively the problems there presented."

---

[1] Results of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado in Arizona. North American Funa. No. 3. U. S. Dept. Agricult., Divis. Ornith. and Mammal. Washington, 1890. 136 pp., 13 plates and 5 maps.

[2] "The extremes of temperature are well illustrated by the fact that the lowest temperature of the twenty-four hours at the bottom of the canon was 80° Fahr. at 4 A. M., September 13, while at the same time thick ice formed on a bucket of water at the top of the cañon.

Coville and McDougal give the following brief sketch of the flora of the Bright Angel Trail:[1] "A visit was made to the Grand Cañon of the Colorado with the expectation that its lower elevations would afford lodgment for many desert plants, and that a descent from the timbered rim at 6,866 feet, to the river at 2,436 feet, would permit the traveller to see in a brief trip a wide range of desert vegetation. Although the descent is full of botanical interest, and does carry one down through several different belts of vegetation, the comparatively limited number of woody desert plants rendered the journey somewhat disappointing from the standpoint of the main object of our trip. For the first 2,600 feet of the descent the trees continue, but from that point to the river the slopes are treeless and the vegetation of a desert character. One of the most striking features is extensive fields of a rosaceous shrub, *Coleogyne ramosissima*, which extends in an almost pure growth over the canyon terraces at an elevation of about 3,600 feet in a soil seemingly well supplied with lime. There is a notable absence of many shrubs which would be present in the open desert at the elevations afforded by the lower parts of the canyon and which have a seemingly good route for extension up the canyon from the Mojave desert. The absence of these plants is presumably connected with the narrowness of the canyon, which besides producing abnormal air currents and temperature conditions is responsible for a rainfall greater than would occur at the same elevations in the open desert. A cloud sheet precipitating rain on the 7,000-foot plateau through which the canyon passes would presumably continue to precipitate as it drifted across the canyon, whereas if it should drift off the plateau over a desert of low elevation its precipitation would be greatly lessened or would cease altogether."

---

[1] Desert Botanical Laboratory of the Carnegie Institution. Washington, Carnegie Institution. November, 1903, 58 pp., 29 pll. and 4 text-figs.

In walking down the Bright Angel Trail from the beautiful Kohonino Forest to the river, one can hardly fail to be impressed by the dryness of the walls of the vast chasm, the steadily increasing temperature, and the wonderful, omnipresent evidences of erosion caused by the torrential floods which at certain seasons must rush down the precipitous inclines. As steepness and dryness of slope are always unfavorable to ant-life, we are not surprised to find their colonies few and widely scattered, of small size and showing other evidences of adverse conditions, especially in unusual forms of nest architecture. At an altitude of 3670 feet on the trail, at a place called Indian Garden, there is a beautiful stream overgrown by low willows and hence known as Willow Creek, where the much less precipitous and more humid soil favors the development of colonies. On the adjoining Angel Plateau (3700 feet) which is covered with the *Coleogyne ramosissima* mentioned and figured by Coville and McDougal, the level is also more favorable, but here the soil is very dry and stony and actually much poorer in species than the deserts of the Lower Colorado. Finally, in the granite strata which extend to an elevation of 1000 or 1200 feet above the river and constitute the hard, sombre walls of the "inner cañon," there are no ants except where the sand

and pebbles have been washed into crevices or depressions or under rocks in the boulder beds of the streams.

As ants, with the exception of certain peculiarly modified desert species, are intimately dependent on moisture, we find that most of the species collected occur in the Kohonino Forest and about Willow Creek in the Indian Garden. But the species of these two localities, separated by an altitude of about 3400 feet, are almost entirely different: those on the Kohonino Plateau belonging to the general Rocky Mountain fauna of the same or similar altitudes (6000 to 8000 feet), whereas those of the Indian Garden are in large part identical with the species of the warmer and moister spots in Texas and New Mexico. The Kohonino fauna extends down sparingly on the walls of the cañon to the lower limit of coniferous trees at an altitude of about 4500 feet. The Formicidæ of the Angel Plateau and lower portions of the cañon to the river belong, like the flora, to well-known desert species widely distributed through western Texas, the southern portions of New Mexico, Arizona and California and the adjoining portions of Mexico at corresponding elevations. We may therefore distinguish the following four faunal zones in the distribution of the Formicidæ of the cañon:

1. The fauna of the rim and cañon walls from about 7000 feet down to an altitude of about 4000 feet. The most characteristic species of this zone is the "occident ant" of McCook (*Pogonomyrmex occidentalis*). The list of species comprises the following:

Monomorium minimum,
Cremastogaster lineolata,
Pheidole ceres,
Myrmica scabrinodis,
Pogonomyrmex occidentalis,
Leptothorax nitens,
Leptothorax neomexicanus,
Liometopum luctuosum,
Dorymyrmex pryamicus,
Tapinoma sessile,
Lasius americanus,
Formica moki,
Formica argentata,
Formica neorufibarbis,
Formica subpolita,
Camponotus nitidiventris,
Camponotus maccooki.

2. The Indian Garden fauna, which is in all probability representative of all the other humid spots in the cañon at the same elevation. This fauna comprises the following species:

Ponera opaciceps,
Myrmecina brevispinosa,
Monomorium minimum,
Pheidole vinelandica,
Aphænogaster texana,
Dorymyrmex pyramicus,
Iridomyrmex analis,
Nylanderia imparis,
Lasius americanus,
Formica gnava.

3. The fauna of the Angel Plateau and the adjacent dry boulder

beds is very meager and, so far as I have observed, represented only by the following, of which the second is the most common and characteristic:

Pheidole maricopa,
Pogonomyrmex rugosus,
Dorymyrmex pyramicus,
Iridomyrmex analis.

4. The warm desert zone, extending from the Angel Plateau to the river, comprises some half dozen species, of which the California harvester (*Pogonomyrmex californicus*) is the most abundant and characteristic:

Ponera opaciceps,
Solenopsis aurea,
Pogonomyrmex californicus,
Dorymyrmex pyramicus,
Prenolepis guatemalensis,
Myrmecocystus melliger.

A comparison of these lists shows that only a single species, *Dorymyrmex pyramicus*, ranges from the top to the bottom of the cañon. Of the other species only a few extend over more than one of the zones. Thus the Kohonino and Indian Garden zones have in common only the widely distributed *Lasius americanus* and *Monomorium minimum*. *Iridomyrmex analis* is common to the Indian Garden and Angel Plateau and *Ponera opaciceps* to the former and the desert zone of the cañon bottom. Excluding the humid zones and patches represented by the Indian Garden, we may say that each of the cañon zones is characterized by a species of *Pogonomyrmex*, the uppermost and coldest by *P. occidentalis*, the lowermost and warmest by *P. californicus*, and the intermediate zone by a form of the widely distributed *P. barbatus*. Each of these species occupies on the cañon walls a position which, with respect to altitude, moisture and temperature, corresponds very closely with its distribution over the vast stretches of country to the north and south of the cañon.

Whence came the species found in the different zones of the cañon? There can be no doubt that the colonies were founded by isolated queens that had drifted into the cañon while on their marriage flight. Although these insects are certainly carried long distances by the wind and must fall into the cañon in great numbers during the late spring and early summer months, it is equally certain that they can establish their colonies only under the most favorable conditions of soil, temperature and moisture. In this respect they resemble the wind-borne seeds of plants. Queens falling on inhospitable ground must either perish or run about till they find the proper sites for the establishment of their colonies. This is indicated very clearly in the sharp zonal demarcation of the various species on the walls of the cañon.

While it is equally clear that the ants of the rim can readily descend to the lower limit of the coniferous trees, it is not so easy to account for the origin of the fauna of the three lower zones. Spots like the Indian Garden, which are veritable oases, confined to springs and damp stream beds, probably derive their fauna from similar but more extensive areas in New Mexico, Arizona and Texas. I have taken all of the species of ants of the Indian Garden in similar locations in central Texas and the valley of the Rio Grande, with the exception of *Nylanderia imparis*. This ant, so common in our northern woods, occurs also in the mountains of Colorado and California and may have been overlooked among the species occurring on the Kohonino Plateau. One of the most abundant ants of the Indian Garden, *Formica gnava*, is very characteristic of the banks of streams in central and western Texas and parts of Colorado.

Two sources suggest themselves for the fauna of the Angel Plateau and the lower reaches of the cañon, namely, the Desert of the Little Colorado to the east and the more remote deserts about the Lower Colorado and Gila Rivers in southwestern Arizona. The ant-fauna of the latter region, as I can state from personal observation, comprises the very species found in the two arid zones of the cañon, in addition to several species which future collectors, working along other trails, will probably bring to light. The alternative sources above suggested are really reducible to one if we accept the view advanced by Merriam in regard to the origin of the fauna of the Desert of the Little Colorado, or Painted Desert, as it is sometimes called. He says: "The Desert of the Little Colorado, it will be remembered, is a deep basin on top of the Great Colorado Plateau. It is wholly disconnected from the desert region of Southern Arizona by the elevated and timber-covered highlands occupying the crest of the plateau escarpment. In fact the highest part of Arizona south of the Grand Cañon, except a few isolated mountains, is the edge of this plateau, which is nowhere below 2,130 meters (7,000 feet) and in places rises to the height of 2,740 meters (9,000 feet), as at the Mogollon Mesa. On the east the desert is separated from the valley of the Upper Rio Grande by a broad area covered with cedar and piñon, through which the continental divide passes, at an elevation of upwards of 2,130 meters (7,000 feet). Therefore the only possible channel through which the fauna and flora of the Painted Desert could have reached this desert during existing climatic conditions is by way of the Grand Cañon of the Colorado. At first thought it seems incredible that a fauna and flora should extend several hundred miles through a chasm of this character; but the evidence at hand indicates that it does. . . . The inference is that the life of the Painted Desert is derived from the deserts of western Arizona, and that it came by the roundabout way of the Grand Canoñ of the Colorado."

Merriam also calls attention to the occurrence near the bottom of the cañon of two lizards (*Sceloporus clarkii* and *Uta symmetrica*) "which belong to the torrid fauna of southern and western Arizona, and are not known to reach the Painted Desert." I believe that Merriam's interpretation will also hold good of the origin of the ant-fauna in the lower zones of the cañon; this fauna has simply advanced up the long, deep chasm from the deserts around the lowermost portion of the river. Further collections of the ants at different points in the cañon will undoubtedly add several desert species to my list. Among those which should occur at the lower elevations in the cañon are certain pale varieties of the honey ant (*Myrmecocystus melliger*) and of *Dorymyrmex pyramicus* (var. *bicolor*) which are common in the Mojave Desert, several species of *Pogonomyrmex* (*P. desertorum, dentatus* and varieties of *P. californicus* and *imberbiculus*), and above all the desert species of *Pheidole* and *Stenamma* (*S.* [*Ischnomyrmex*] *cockerelli* and *albisetosum* and *S.* [*Messor*] *pergandei*). One of the most interesting ants of the deserts of Arizona and California is *Messor pergandei*, which builds flat craters from a foot to 18 inches in diameter, with single or double entrances of very irregular outline, and garners great quantities of seeds. *Ischnomyrmex cockerelli* and *albisetosum* make similar but larger nests and have very similar habits. Owing to the limited supply of insect food obtainable in the desert during the greater part of the year, these ants, like the species of *Messor*, *Pogonomyrmex* and several species of *Pheidole*, are compelled to subsist on seeds.

Further details concerning the ants found in the Grand Cañon, together with descriptions of a few new forms, are included in the following systematic list:

Subfamily PONERINÆ.

1. **Ponera opaciceps** *Mayr.*—Several workers of this species were collected under stones beneath the willows of the Indian Garden. A single individual was taken in the bottom of a creek near the river.

Subfamily MYRMICINÆ.

2. **Myrmecina graminicola americana** *Emery* var. **brevispinosa** *Emery.*—Several workers which agree very closely with northern

specimens of this variety were taken under stones at the Indian Garden in the same places as the preceding. A similar variety of *M. americana* occurs also in the creek bottoms of Travis County, Texas.

3. **Cremastogaster lineolata** *Say.*—A single worker of this species, near the subspecies *coarctata* Emery var. *mormonum* Emery, was found running on the wall of the cañon at an elevation of about 5000 feet.

4. **Monomorium minutum** *Mayr* var. **minimum** *Buckley.*—Common under stones in the Kohonino Forest and near the Indian Garden. The colonies were in all respects like those found in Texas and New Jersey. This variety ranges as far north as Colorado and Massachusetts.

5. **Solenopsis geminata** *Fabr.* var. **aurea** var. nov.

Worker. Length 2–3.5 mm.

Deep yellow; mandibles and posterior margins of gastric segments brownish; mandibular teeth black.

Female. Length 5.–5.5 mm.

Deep yellow, like the worker; each gastric segment with a broad brown band, the one on the first segment sometimes nearly or quite interrupted in the middle. Wings whitish hyaline, with yellow stigma and veins. Each ocellus with a small brown spot near its inner margin.

Male. Length 5 mm.

Piceous brown; upper surface of head, thorax and gaster darker; mouthparts, antennæ, thoracic sutures and legs yellow; genitalia somewhat paler. Wings as in the female.

The types of this variety are from Mt. Bonnel near Austin, Texas. It is undoubtedly distinct from the typical form of the species, differing in its smaller size, much paler coloration, and in living in rather small colonies under stones in dry, stony situations. It appears to be nocturnal or hypogæic, unlike the typical *geminata*, which is found abroad at all hours of the day. I have taken the variety also at Fort Davis, Texas, on the dry summit of the Crouching Lion, and there are two specimens from Visalia, California, in my collection. A few workers were found under stones in the bottom of the Grand Cañon near the river.

6. **Pheidole vinelandica** *Forel.*—A few colonies of this species were seen along the Bright Angel Trail just above the Indian Garden at an elevation of about 3700 feet. It is common in central Texas and occurs near Colorado Springs, Colorado, at an altitude of 5000 to 6000 feet, extending north and east as far as New Jersey and

southern New York. It is a grain-storing species and seems to build indifferently under stones or in the open soil. In the latter case its shallow nests are surmounted by straggling craters scarcely more than an inch in diameter.

7. **Pheidole ceres** *Wheeler.*—A few colonies of this seed-storing species, which is common through the mountains of Colorado at an elevation of 6000 to 8000 feet, were found under stones near the Bright Angel Hotel on the rim of the cañon.

8. **Pheidole desertorum** sp. nov.

Soldier. Length 4.5–5 mm.

Head distinctly longer than broad; sides evenly arcuate, with the rather large convex eyes in front of the middle; posterior margin deeply excised, with a pronounced occipital groove. Mandibles convex, with two stout apical teeth. Clypeus short, flat, carinate in the middle, with a broad median excision in its anterior border. Frontal carinæ about $\frac{1}{3}$ as long as the head; frontal area subtriangular, somewhat truncated behind. Antennæ very slender, scapes slightly curved at the base, but not flattened, slightly thickened towards their tips which extend a little beyond the posterior corners of the head. Funiculus very slender, all the joints more than twice as long as broad; the 3-jointed club more than $\frac{2}{3}$ as long as the remainder of the funiculus, its joints subequal, nearly 4 times as long as broad. Thorax in front half as broad as the head, without distinct humeral angles; promesonotal depression shallow but distinct; mesoëpinotal depression deep. Basal surface of epinotum flat, longer than the declivity, which is sloping and longitudinally impressed in the middle. Epinotal spines small and erect, a little further apart at their bases than long. Petiole more than twice as long as broad; from above somewhat violin-shaped, with a rather high node, compressed anteroposteriorly and somewhat notched in the middle; its anterior slope long and concave, its posterior slope short and abrupt. Postpetiole short, about twice as broad as long, gradually narrowed anteriorly, truncated behind; in profile rounded above in front and abruptly concave behind. Lower surfaces of petiole and postpetiole rather flat. Gaster smaller than the head. Legs long and slender.

Shining; mandibles very sparsely and coarsely punctate; punctures elongated and parallel on the inner edges of the blades, outer basal surfaces very coarsely striated. Clypeus smooth in the middle, striated on the sides. Frontal area smooth. Anterior $\frac{3}{4}$ of head longitudinally and somewhat reticulately rugose, most distinctly on the cheeks and between the frontal carinæ; the spaces between the rugæ more or less punctate. Posterior corners smooth, without distinct punctures. Prothorax shining; meso- and metathorax with dense but shallow punctures. Petiole and postpetiole finely punctate, except the dorsal portion of the former, which is smooth. Gaster finely shagreened at the base.

Hairs abundant, suberect, pale yellow, covering the body and appendages throughout.

Body yellowish red or reddish brown; mandibles, clypeus and pedicel somewhat darker; gaster and edges of mandibles black, the base of the former yellowish or brownish. Legs and antennæ yellow.

Worker. Length 3–3.25 mm.

Head longer than broad, elliptical, narrowed but not conical behind the eyes; without posterior angles and with a constricted and marginate posterior border. Eyes a little in front of the middle of the head. Mandibles with two larger apical teeth and numerous smaller basal teeth. Anterior clypeal border sinuately excised in the middle. Antennæ very slender; scapes extending about ⅔ their length beyond the posterior corners of the head; funicular joints like those of the soldier. Thorax long and narrow, flattened above, with indistinct promesonotal depression; mesoëpinotal depression short and deep. Epinotal spines small and acute, directed upward and somewhat outward, nearly twice as far apart at their bases as long. Petiole slender, fully three times as long as broad, very little wider behind than in front, with subparallel sides; in profile with a short, rounded node near the posterior end. Postpetiole barely twice as broad as the petiole, as long as broad, subglobular. Gaster about the size of the head. Legs very long and slender.

Body smooth and shining. Mandibles indistinctly punctate. Epinotum and mesopleuræ subopaque, evenly punctate.

Pilosity like that of the soldier but less abundant.

Dark brown or piceous; mandibles and clypeus yellow; mandibular teeth black; legs somewhat paler than the body.

Female (deälated). Length 6.5–7 mm.

Head resembling that of the soldier, but the longitudinal rugæ and the punctation extend onto the posterior corners, so that these are subopaque. Clypeus depressed in the middle, sharply carinate and longitudinally rugose. Antennal scapes as long as those of the soldier but distinctly incrassated and slightly flattened at their bases. Epinotum with short, robust spines, its sides irregularly and longitudinally striated, the region between the spines with dense, shallow punctures. Mesonotum smooth and shining, with a finely, longitudinally and coarsely punctate area on either side of the middle line. Scutellum coarsely and sparsely punctate, with a few striæ running parallel with the posterior border. Petiole and postpetiole opaque, very finely punctate; the former twice as broad as long, semicircular in outline from above, in profile with an acute node, the posterior surface of which is strongly concave. Gaster shining, shagreened, especially at the base, and with scattered piligerous punctures. Color and pilosity similar to those of the soldier.

Male. Length 4.5–5.5 mm.

Head, excluding the eyes, longer than broad. Cheeks extremely short, ocellar region very prominent, with straight posterior border. Mandibles very small, with two larger apical and three or four minute basal teeth. Clypeus feebly emarginate in the middle. Antennæ filiform; scape somewhat longer and stouter than the subequal, cylindrical joints 2–12 of the funiculus; first joint subspherical, scarcely broader than the scape. Thorax very robust, nearly twice as broad as the head including the eyes; mesonotum flattened, a little broader than long, without Mayrian furrows. Epinotum short, sloping, with small protuberances in the place of the spines. Petiole 1½ times as long as broad, broadest behind; node rather sharp in profile, with longer, concave, anterior and shorter, concave posterior slopes. Postpetiole 1½ times as broad as the petiole, distinctly broader than long and much broader behind than in front, with subangular sides. Gaster somewhat flattened above, convex on the ventral side. Legs long and slender.

Smooth and shining; head finely granular except on the front; epinotum subopaque, finely punctate.

Hairs like those of the soldier but sparser; pubescence on the antennæ rather conspicuous.

Sordid yellow; head, with the exception of the clypeus and mandibles, black. Posterior ⅔ of scutellum and upper surface of gaster dark brown, anterior portion of basal segment yellow. Wings grayish hyaline, with brown stigma and yellowish veins.

The types of this species, comprising several specimens of each of the above described phases, were taken at Fort Davis, Texas (5400 feet), during June, 1902. It forms rather populous colonies under stones or in rough crater nests, often in very dry spots in the desert, and like *Ph. dentata* is highly carnivorous. I have taken it also at Ash Fork, Prescott, Phoenix, and Tucson, Arizona (May, 1905). In Prescott one of the colonies was found nesting in a dry pine log. In both soldiers and workers from this locality the epinotal spines are very short, almost absent in the worker. The two following varieties may be distinguished among my specimens from other localities in the southwest:

Pheidole desertorum var. **comanche** var. nov.

Based on numerous soldiers and workers taken in the Paisano Pass near Alpine, Texas, (5079 feet, June, 1902) and at Terlingua in the Great Bend of the Rio Grande (Dec. 1901). These specimens are much darker than those of the typical form, the head, thorax, pedicel and gaster both in the soldier and worker being uniformly chestnut brown, the legs yellowish. The head of the soldier is somewhat more shining, especially behind. A single deälated female of this variety from the Paisano Pass differs from the female of the typical form in having the gaster black and the mesonotum darker in the middle.

Pheidole desertorum var. **maricopa** var. nov.

In this variety the soldiers and workers are yellow throughout, except the borders of the mandibles, frontal carinæ and anterior border of the clypeus, which are dark brown, and the antennal scapes and occipital groove, which are reddish. The head of the soldier is less shining than in the preceding variety and the mandibles have minute teeth along their basal border.

Described from several soldiers and workers taken from a single colony under a stone in the Grand Cañon just above the Indian Garden (3876 feet.)

Ph. desertorum is allied to *Ph. susannæ* Forel of the American tropics and *Ph. longipes* Pergande of Mexico. From *susannæ* it differs in its larger size, much longer antennæ in the soldier and much slighter constriction of the occiput in the worker. Comparison of my specimens of *desertorum* with Pergande's description of the soldier of *longipes*, with a type specimen of the worker of this species and another worker from San Jacinto, California, given me by Prof. Emery, shows a number of differences. Pergande describes the space between the frontal carinæ of the soldier as "quite smooth and faintly shagreened," the posterior half of the head as having "elongated shallow depressions", etc. The worker of *longipes*, like that of *susannæ*, has the head produced and much constricted in the occipital region and "forming a distinct neck", the long basal surface of the epinotum is distinctly convex, and the petiole is more campanulate than in *desertorum*.

9 **Myrmica rubra scabrinodis** *Nylander.*—A single colony of a small, dark-colored variety of this subspecies, with rather large, rounded, calyculate lobes on the base of the antennal scapes of the worker and female, was found under a stone in the Kohonino Forest on the rim of the cañon. This variety closely resembles a form not uncommon in the mountains of Colorado at a corresponding elevation, and others peculiar to the shady woods and tamarack bogs of the northern States.

10. **Pogonomyrmex occidentalis** *Cresson.*—The "occident ant" may be found nesting all the way from Ash Fork and Williams, Arizona, to the Grand Cañon, and from the rim of the latter to an altitude of 4000 feet, but not lower. The nests near Ash Fork and Williams are large and typical, with great bare areas, often 20 or 30 feet in diameter, surrounding their elegant gravel cones, but in the Kohonino Forest and especially on the walls of the cañon, they exhibit unmistakable effects of adverse conditions. The absence of horizontal surfaces and the washing of rains have induced the insects to nest under large stones or in crevices of the rock. They still heap the pebbles about the entrance, but the nests are merely caricatures of the fine structures in the plateau region. *P. occidentalis* is the ant *par excellence* of the Great Plains. A study of its distribution from Montana, Wyoming and Colorado to Arizona and New Mexico, shows that it is at its best only at an elevation of 6000 to 7000 feet and that it rarely descends below 4000 or 5000 feet.

11. **Pogonomyrmex barbatus rugosus** *Emery.*—Many workers of what I regard as a variety of this subspecies, were taken on the Angel Plateau (3700 feet) and down to an altitude of about 3000 feet, but not lower. The workers are somewhat smaller and smoother than the typical *rugosus*, which is common in the deserts about Tucson. The rugæ of the petiolar node are irregular and subreticulate. The base of the gaster has two large yellow or red spots. The nests, which, like those of the typical *rugosus*, are flat gravel discs 3 to 4 feet in diameter, were especially abundant in the *Coleogyne* zone. The ants were busily collecting the seeds of grasses and other herbaceous plants.

12. **Pogonomyrmex californicus** *Buckley.*—This ant occurs from just below the Angel Plateau to the river bottom, slightly overlapping the range of the preceding species. Its true home is in the torrid deserts of southwestern Arizona and southern California, where it prefers to nest in pure sand. I have also found it abundant at Albuquerque, New Mexico, and in a somewhat depauperate condition near Marfa in western Texas. Its nests are low, flat craters from 6 inches to a foot or more in diameter, with elegantly rounded slopes and slanting, usually somewhat excentric entrances. The workers can sting severely and those of large colonies actively resent any interference with their nests. They run rapidly with the gaster conspicuously elevated.

13. **Stenamma (Aphænogaster) fulvum** *Roger* var. **texanum** *Emery.*—Five workers taken under stones at the Indian Garden agree with specimens of this variety from Austin and New Braunfels, Texas, except that they are somewhat larger and have the head and thorax somewhat more coarsely sculptured. The body is slightly redder and the gaster is infuscated. In Texas the variety occurs in rather shady damp portions of the live-oak woods and mesquite thickets, and is never found in dry, open country.

14. **Leptothorax nitens** *Emery.*— A few colonies of a pure yellow form of this species were seen under stones in the Kohonino Forest on the rim of the cañon.

15. **Leptothorax neomexicanus** *Wheeler.*—A single small colony of this species was found under a stone in the same locality as the preceding.

Subfamily DOLICHODERINÆ.

16. **Liometopum apiculatum luctuosum** *Wheeler.*—This subspecies is common in the Kohonino Forest on the rim of the cañon and extends down the walls sparingly to an altitude of about 4000 feet.

As I have shown in a former paper[1] this ant occurs in populous colonies and moves about in files in search of insect foot and the sweet excretions of plant-lice. It appears to be more definitely associated with pine trees than the typical *apiculatum.*

17. **Dorymyrmex pyramicus** *Roger.*—This ant, the only species found over the whole cañon wall from the rim to the river, constructs crater nests somewhat larger than those of *Lasius niger.* It is common throughout Mexico, the West Indies and the southern and southwestern Stares, ranging as far north as New Jersey and Illinois. The form occurring in the Grand Cañon is somewhat smaller and paler than the var. *niger* Pergande and hence approaches very nearly the typical form of the species.

A clearly marked variety which may be called **bicolor** var. nov. has the head, thorax and petiole of the worker and female red, the gaster black. It occurs in pure sand from central Texas to the Mojave Desert of California and will probably be found in the lower reaches of the Grand Cañon. I have taken specimens of this variety at New Braunfels and Elgin, Texas, Phoenix, Tucson and Yucca, Arizona, and at Needles, California. It has also been taken at San Pedro, California, by Prof. T. D. A. Cockerell, and at Tuxpan, Jalisco, Mexico, by J. F. McClendon.

18. **Iridomyrmex analis** *André.*—Many populous colonies of this ant, teeming with larvæ and nude pupæ, were found under stones in the Indian Garden and down the cañon to a level of about 3000 feet, but the species was not seen on the rim or at the bottom.

19. **Tapinoma sessile** *Say.*—The common dark form of this widely distributed species is rather common under stones on the Kohonino Plateau. It occurs in similar localities at the same or even much greater elevations in Colorado and New Mexico. I have taken it at Cripple Creek, Colorado, at an altitude of 10,500 feet. In the northeastern States it descends to sea-level.

Subfamily Camponotinæ.

20. **Prenolepis guatemalensis** *Forel.*—A number of workers assignable to this species, were taken in the sand under stones in a creek bottom near the river along the lowermost portion of the Bright Angel Trail.

21. **Prenolepis (Nylanderia) imparis** *Say.*—A form of this species almost as light as var. *testacea* Emery, was common under stones in

---

[1] The North American Ants of the Genus Liometopum. Bull. Am Mus. Nat. Hist., XXI, 1905, pp. 321–333, 3 figs.

the Indian Garden. There I also found a solitary deälated female, with a cluster of small larvæ in the act of establishing her formicary. Many of the workers in these colonies were in a replete condition, indicating that they got their food from aphids or coccids. In the northern States I have seen hundreds of nests of this ant but on only two occasions have I found it nesting under stones. In fact, it seems to have as great an aversion as *Dorymyrmex pyramicus* to nesting in such places. In the Grand Cañon it is probably compelled to abandon its usual habits and to nest under stones for protection against the scouring rains.

22. **Lasius niger** *Linn.* var. **americanus** *Emery.*—A small yellowish form of this variety is common under stones in the Kohonino Forest on the rim of the cañon and occurs also but more sparingly at the Indian Garden. It is also common on the rocky hills about Prescott, Arizona, and Las Vegas, New Mexico, where the soil and elevation are like those on the rim of the cañon.

23. **Formica moki** sp. nov.

Worker. Length 4–5.5 mm.

Mandibles 8-toothed. Palpi long and slender. Head decidedly longer than broad, with rather straight sides, converging anteriorly, posterior margin straight, posterior corners rounded. Eyes large and convex. Clypeus with a very prominent keel, its anterior border entire, projecting in the middle. Antennæ slender, three basal funicular joints more elongated than joints 6 to 8; first and third joints equal, longer than the second joint; none of the joints less than twice as long as broad. Thorax long and narrow, in profile very low; pro- and mesonotum depressed, mesoëpinotal constriction shallow and very long at the bottom. Epinotum with flat basal surface, nearly twice as long as the very sloping declivity. Seen from above the pronotum is as long as broad, mesonotum nearly twice as long as broad. Petiole narrow, thick at the base, with sharp, horizontal upper border, and both the anterior and posterior surfaces, but especially the latter, distinctly flattened, so that the segment is cuneate in profile. Gaster small. Legs long and slender.

Subopaque; frontal area, sides of clypeus and bases of mandibles somewhat shining. Blades of mandibles rather coarsely striatopunctate. Head behind with a bronzy or glossy surface.

Body and appendages covered with fine grayish pubescence, which is densest and most conspicuous on the gaster and posterior portion of the head, sparser, but still readily discernible on the upper surface of the thorax and petiole and lower surface of the head. On the gaster a few of the hairs along the posterior borders of the segments are thick and obtuse. Legs with graduated, oblique, tapering hairs on the flexor surface of the tibiæ.

Dull reddish yellow; gaster dark brown or fuscous, as are also the posterior half of the head above, a large cloud on the pronotum, another on the mesonotum, the upper portion of the petiole, the coxæ, femora, and in some specimens also the apical half of each tibia. In some specimens the pleuræ also are more or less infuscated.

Described from 25 workers taken from a small colony under a stone on the wall of the Grand Cañon at an altitude of about 5500 feet and 2 workers taken on the rim in the Kohonino Forest (7000 feet) about three miles west of the Bright Angel Hotel.

This species seems to belong to the *Formica rufa* group although certain characters ally it with *F. fusca.* At first sight it resembles rather deeply colored specimens of the var. *neoclara* Emery of the latter species, but it differs from this and all the other North American *Formicæ* known to me in the very low and flat thorax and the length of the mesoëpinotal constriction. In these respects it approaches the forms of the *pallide-fulva* group, but the surface of the body is subopaque as in the smaller species allied to *F. rufa.* It will be impossible to assign *F. moki* to a precise position in the genus till the female is discovered.

24. **Formica fusca** *Linn.* var. **argentata** *Wheeler.*—Workers from one small colony of this subboreal variety were taken on the rim of the cañon at an elevation of a little over 7000 feet. No sharp line can be drawn between *argentata* and var. *subsericea* Say although it is easy to distinguish extreme specimens of the two varieties. *F. argentata* is more abundant in the western States at considerable elevations, *subsericea* in the eastern and middle States at lower altitudes.

25. **Formica fusca** *Linn.* var. **gnava** *Buckley.*—Numerous small colonies were found nesting in the grass and among the willows at the Indian Garden. The workers of this variety, which is quite distinct from the var. *neorufibarbis* Emery, in having the gaster much more pubescent and therefore more opaque, are indistinguishable from specimens taken from larger colonies in similar situations in other parts of Arizona (Ash Fork and Prescott and in Texas [Austin, New Braunfels, San Angelo, Fort Davis, Langtry, etc.]). This ant always prefers the moist shady banks of streams and is never found in the dry open country.

26. **Formica fusca** *Linn.* var. **neorufibarbis** *Emery.*—This variety, which is rare on the rim of the cañon at an elevation of 7000 feet, is similar in coloration and sculpture to *F. subpolita* Mayr, but lacks the erect hairs on the lower surface of the head. It belongs to the Canadian and Hudsonian zones and in the United States seems rarely to descend below 7000 or 8000 feet. In Colorado I have taken it only in the higher cañons and near timber-line on the mountains.

It is known to occur in Alaska, and in British America ranges as far east as Labrador and Nova Scotia.

27. **Formica fusca subpolita** *Mayr.*—Several colonies of this subspecies were seen nesting under stones in the Kohonino Forest on the rim of the cañon. It is common in similar situations throughout New Mexico, Colorado and California.

28. **Myrmecocystus melliger** *Forel.*—A single colony of a dark variety of the "honey ant", common in the deserts of southwestern Arizona, was seen between the upper limit of the granite and the *Coleogyne* zone, at an altitude of about 3000 feet.

29. **Camponotus maculatus vicinus** *Mayr* var. **nitidiventris** *Emery.*—Common in the Kohonino Forest on the rim of the cañon, where it forms populous colonies under large flat stones or even burrows in the open ground. In the latter case the nest-entrances are obscure and widely scattered craters. Winged females and males are common in the nests during May. Colonies extend down the cañon walls to an altitude of about 4000 feet. The variety is common at similar elevations in Arizona, New Mexico, and Colorado.

30. **Camponotus maculatus maccooki** *Forel.*—Several colonies of this ant were taken in the Kohonino Forest and down the walls of the cañon to an altitude of 5360 feet. Like the subspecies *vicinus* it nests under flat stones or in the open soil and resembles in its habits the var. *sansabeanus* Buckley of central Texas. I have taken it also on the rocky elevations about Prescott, Arizona, and in the vicinity of Manitou, Colorado.

59.57,96(729.9)

Article XX.—THE ANTS OF THE BERMUDAS.

By William Morton Wheeler.

Professor Trevor Kincaid has recently sent me a small collection of ants, the study of which affords an opportunity of bringing together the little that is known concerning the ant-fauna of the Bermuda Islands. In this undertaking I have been materially aided by Professor A. E. Verrill's comprehensive work,[1] in which he has collected the scattered references to the Formicidæ. These references, together with the specimens taken by Professor Kincaid, indicate that the ant-fauna of the Bermudas is extremely meager. This is not surprising when we stop to consider the geological history of these isolated islands and the fact that their present terrestrial fauna and flora is very largely, if not exclusively, made up of species that have been introduced since glacial times by commerce or by purely accidental agencies. The ants certainly belong to widely distributed species, several of which have made their way as well-known tramps or stow-aways to many other islands besides the Bermudas. Even the single new species (*Prenolepis kincaidi*) described in the present paper is probably of West Indian origin.

There seem to have been times in the history of the Bermudas, however, when the ants made up in number of individuals for what they lacked in variety of species. This is shown by the extracts quoted by Professor Verrill from the works of Governor Butler[2] and Hurdis.[3]

In the following quaint passage Governor Butler mentions certain ants which were making the lives of the inhabitants uncomfortable as early as the beginning of the seventeenth century: "The moscitoes and flies also are somewhat over busie, with a certain Indian bugge called, by a Spanish appellation a caca-roche, the which, creepeinge into chestes and boxes, eate and defile with their dung (and thence their Spanish name) all they meet with; as doe likewise the little aunt, which are in summer time in infinite numbers; worms in the earth and mould also, ther are but too many (but of them we shall saye somewhat more by and by), as likewise the grass-hopper, and a certaine sommer-singinge great flie, the sure token of the established springe (and in that respect as the English nightingale and cukoe), whose loud note very much resemblinge the whirle of a spindle, hath caused herselfe thereby to be called the good-husewife." Hurdis mentions two species of Formicidæ, a house-ant and another ant of larger size which he supposed to be of West Indian origin: "Hill and dale and even the dwellings of men were equally alive with this insect pest. Dense columns of them might be seen travelling up and down every tree, and great was the havoc they occasioned among young pigeons and poultry, nor did the full-grown domestic rabbit escape their deadly attack, and pigs were sometimes destroyed by them." It is, of course, impossible to identify the species from these quotations. Hurdis's account may refer to the tropicopolitan fire-ant (*Solenopsis geminata*) or to *Monomorium destructor*, but whether he refers to one of these or to some other species, it is certainly of interest that no such species can be recognized among those enumerated by subsequent writers. He mentions the fact that the ant, after infesting Bermuda to a "fearful degree" for seven consecutive summers previous to 1848, was greatly reduced in numbers from some unknown cause. We must conclude that it has since become extinct or, at any rate, so rare as to have escaped the notice of subsequent collectors like Professor Verrill and Professor Kincaid. The supplanting of one species of ant by another is not unknown on other islands as I have shown in a recent paper.[1] In Madeira, for example, according to Stoll,[2] *Pheidole megacephala*, which was extremely abundant in the first half of the nineteenth century, as we learn from the careful work of Heer,[3] has been displaced by another tramp species, *Iridomyrmex humilis*. Stoll has also called attention to the extermination of the indigenous ant-fauna of the island of Reunion by *Plagiolepis longipes* of Cochin China.

---

[1] The Bermuda Islands, an Account of their Scenery, Climate, Productions, Physiography, Natural History, and Geology, with Sketches of their Discovery and Early History, and the Changes in their Flora and Fauna due to Man, with 38 Plates and over 250 Cuts in the Text. Reprinted from the Trans. Connecticut Acad. Sci., Vol. XI, with some changes. New Haven, Conn. 1902.

[2] Gov. Nathaniel Butler. Historye of the Bermudaes, 1609–22.

[3] John L. Hurdis. Rough Notes and Memoranda relating to the Natural History of the Bermudas. Edited by H. J. Hurdis from MS. notes mostly made from 1847–1855. London, 1897.

If we omit the ants mentioned by Hurdis as unrecognizable, the following list comprises all the species known from the Bermudas:

Subfamily PONERINÆ.

1. **Ponera opaciceps** *Mayr.*—A deälated female and five workers collected by Professor Kincaid belong to the typical form of this species.

---

[1] On Certain Tropical Ants Introduced into the United States. Entomol. News, Jan., 1906, pp. 23–26.

[2] Zur Kenntniss der geographischen Verbreitung der Ameisen. Mittheil. d. Schweiz. entomol. Gesell., X, 3, 1898, pp. 120–126.

[3] Ueber die Hausameise Madeiras. An die Züricher Jugend auf das Jahr 1852 v. d. naturforsch. Gesell. 54. Stuck, 1852, pp. 1–24, 1 Taf.

2. **Odontomachus hæmatodes insularis** *Guérin.*—This is evidently the form mentioned by Dahl[1] as *Odontomachus* sp. Among the material collected by Professor Kincaid during July, 1905, are a deälated female and several workers closely resembling in color, sculpture and pilosity the Bahaman variety of *insularis* which I have called *ruginodis.*

Subfamily MYRMICINÆ.

3. **Monomorium pharaonis** *Linn.*—I am inclined to believe that this cosmopolitan house-ant is the one mentioned by Professor Verrill as occurring in the Bermudas, and not *M. minutum,* of which he reproduces Marlatt's figure. The latter species is not a house-ant.

4. **Cardiocondyla emeryi** *Forel.*—A worker and two males collected by Professor Kincaid.

5. **Pheidole megacephala** *Fabr.*—This species was found in Bermuda by Dahl, who, like Professor Verrill, mentions it under the name of *Ph. pusilla* Heer. Professor Kincaid has sent me several males, winged and deälated females, soldiers and workers taken from at least four different colonies, and Prof. J. H. Comstock has sent me a soldier and worker. Professor Verrill mentions specimens from St. David's Island. It is probably very common throughout the Bermudas and may be responsible for the small number of species in the islands. It is not, however, a native of Madeira, as Professor Verrill states, but a well-known tropicopolitan ant, which, as above stated, overran that island in the first half of the nineteenth century. There can be little doubt that wherever it gains a foothold in tropical or subtropical countries it is able to propagate very rapidly, and to exterminate the indigenous ant-fauna. I have recently seen a good illustration of its habits in the Virgin Islands. During the past March I devoted ten days to a careful study of the aunt-fauna of the little island of Culebra off the eastern coast of Porto Rico without seeing a single specimen of *Ph. megacephala.* This island is, however, completely overrun with a dark variety of the vicious fire-ant (*Solenopsis geminata*). One day, on visiting the island of Culebrita, which is separated by a shallow channel hardly a mile in width from the eastern coast of Culebra, I was astonished to find it completely overrun with *Ph. megacephala.* This ant was nesting under every stone and log, from the shifting sand of the sea-beach to the walls of the lighthouse on the highest point of the island. The most careful search failed to reveal the presence of any other species of ant, though

---

[1] Die Landfauna von Bermuda, in: Krummel, Reisebeschr. d. Plankton-Expedition. 1902, pp. 105-112, 1 Taf.

the flora and physical conditions are the same as those of Culebra! It is highly probable that *Ph. megacephala*, perhaps accidentally introduced from the island of St. Thomas a few miles to the east, had exterminated all the other ants which must have previously inhabited Culebrita. The absence of *megacephala* on Culebra is perhaps to be explained by the presence of the equally prolific and pugnacious fire-ant.

6. **Tetramorium cæspitum** *Linn.*—Professor Verrill says that he has recognized this species in the Bermudas. We should have expected the tropicopolitan *T. guineense* Fabr. instead, and venture to doubt the correctness of his identification. Although *T. cæspitum* has been introduced into the United States, I believe there is no record of its introduction into a subtropical country. *T. guineense*, however, is a well-known tramp species, occasionally found even in our northern hot-houses.

Subfamily CAMPONOTINÆ.

7. **Brachymyrmex heeri** *Forel.*—Numerous workers, winged females and males of the typical form of this diminutive ant were collected during July from two colonies by Professor Kincaid. This species together with the following variety has probably been introduced with plants from its original home in the West Indies.

8. **Brachymyrmex heeri** *Forel* var. **obscurior** *Forel.*—Three workers collected by Professor Kincaid.

9. **Prenolepis kincaidi** sp. nov.

Worker. Length 1.3–1.5 mm.

Head rectangular, a little longer than broad, as broad in front as behind. Eyes flattened. Clypeus very convex, subcarinate, its anterior border emarginate in the middle. Front with a transverse welt or swelling between the antennal insertions. Antennæ slender, scapes extending a little more than $\frac{1}{3}$ their length beyond the posterior corners of the head. Thorax robust; pro- and mesonotum of about equal length; mesoëpinotal depression rather shallow and much shorter than the distance between the two stigmata. Epinotum rounded in front, flattened behind, without a distinct angle between the basal and declivous surfaces. Petiole small and narrow, with a blunt and rounded node. Gaster of the usual shape. Legs rather long.

Surface of body, especially the pleuræ, smooth and shining, without perceptible sculpture.

Hairs black, erect, obtuse and abundant on the head, thorax and gaster, more scattered on the legs. The antennal scapes have a few erect white hairs. Pubescence white, very sparse and visible only on the head and legs.

Body dark brown, head and gaster blackish above; antennæ, mouthparts, tibiæ and tarsi yellow.

Female. Length 3.5 mm.

Head about as long as broad, narrower in front than behind, with a straight posterior border. Clypeus convex, distinctly carinate, its anterior border very faintly emarginate in the middle. Antennal scapes extending about ⅓ their length beyond the posterior corners of the head. Front with a transverse ridge between the antennal insertions. Thorax robust, but little broader than the head, flattened above. Epinotum very sloping. Petiole much inclined forward, its posterior surface convex, its upper border sharp and feebly notched in the middle.

Subopaque; thorax, cheeks and posterior corners of the head smooth and shining.

Hairs like those of the worker but proportionally shorter. Pubescence gray, dense, especially on the gaster.

Dark brown; thorax paler, insertions of the wings, sutures and mouthparts yellow, as are also the tarsi and the articulations of the legs and antennæ. Wings grayish hyaline; veins brownish; stigma well-developed, dark brown.

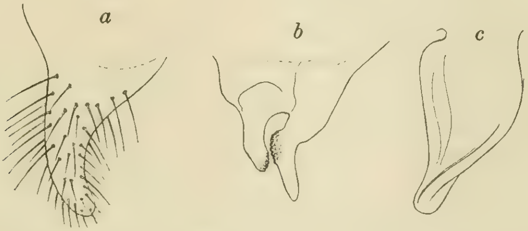


FIG. 1. *Prenolepis kincaidi* sp. nov. Male. *a*, outer; *b*, median, and *c*, inner genital valve.

Male. Length 2.3 mm.

Mandibles with an apical and a smaller subapical tooth. Thorax short, robust, with faintly rounded epinotum. Body shining. Pilosity and coloration as in the worker. Legs slender. Wings like those of the female but without a distinct stigma. Outer genital valves long, slender, and distinctly curved inward, with a blunt point and abundant but rather short hairs (Fig. 1, *a*). Outer process of median valve digitiform, somewhat bent in the middle and with the papillate surface at its tip; inner process nearly twice as long as the outer, slender and tapering, geniculate near its base and with the papillate surface on its basal half some distance from the slender tip (Fig. 1, *b*). Inner valve large, apparently twisted, and tapering to a blunt point like that of the outer valve (Fig. 1, *c*).

Described from four workers, two females and a single male taken from the same colony June 26, 1905, by Professor Kincaid.

I have described this species as new because I fail to find anything like it among the described American or Old World species of *Prenolepis*. In certain respects it resembles *P. anthracina* of Cuba, but

Roger's description of this species is too meager to admit of identification. *P. kincaidi* is evidently allied to *P. vividula* Nyl. and *P. bruesi* Wheeler, but the genital valves of the male are very different.

10. **Prenolepis** sp.—Seven workers, apparently all from the same colony, but varying much in size (from 2–3 mm.) They are very pilose and pubescent, with subopaque surface and finely punctate mesonotum. The species cannot be identified without the corresponding male, for, as Forel has shown, the only satisfactory diagnostic characters of the species in the difficult genus *Prenolepis* are to be found in the genital valves of that sex.

11. **Lasius niger** *Linn.*—This form is mentioned by Kirby[1] under its old name *Formica nigra* Linn. as occurring in the Bermudas. It was probably introduced, as he says, but whether from Europe or the United States it is impossible to ascertain.

---

[1] On the Hymenoptera Collected during the Recent Expedition of H. M. S. "Challenger." Ann. Mag. Nat. Hist., ser. 5, XIII, 1884, pp. 403–413.

56.6 (118)·

Article XXI.—HYPOTHETICAL OUTLINES OF THE CONTINENTS IN TERTIARY TIMES.

By W. D. Matthew.

I. Introductory.

This series of maps was drawn up about three years ago for the fossil mammal hall in the American Museum of Natural History. We found that it was very necessary to have them, in order to illustrate the geographical distribution of different groups of mammals in past geological epochs. The attempt to plot this distribution on modern maps proved unsatisfactory, as it did not explain the cause of the changes in their range. The various palæographic maps already published were not entirely suited to our purpose and it seemed necessary to draw up a new series to represent the seven principal stages in Cenozoic time. This series of world maps on Mercator's projection[1] shows the supposed continental outlines in each epoch as far back as the opening of the Tertiary period. Beyond that it was not necessary to go for our purpose. The series illustrates the outlines during the Recent, early Pleistocene, mid-Pliocene, mid-Miocene, mid-Oligocene and mid-Eocene epochs, approximately speaking, and at the beginning of the Tertiary period.

It is to be understood that these maps are almost entirely hypothetical. There are very few parts of the earth's surface where the data are really adequate, and for the greater part there are absolutely no stratigraphic data of any value.

The maps were exhibited before the New York Academy of Sciences in 1903, and were then set aside in order to present more fully the data on which they are based. Opportunity to do this in adequate form has hitherto been lacking, but there have been so many requests for copies of the series that it seemed advisable to publish them even with a brief and imperfect statement of their basis.

It is hardly necessary to say that a subject of this kind is chiefly a matter of compilation. The outlines in different regions are based upon recently expressed views of the most reliable authorities, so far as I have succeeded in finding and comprehending them. In general it represents a somewhat conservative view, retaining as much as possible the present continental outlines except where the evidence for changing them seemed thoroughly adequate.

---

[1] The maps differ from the ordinary projection in that they are carried to the 75th parallel of north and south latitude instead of to 80° N. and 70° S., as is usual.

The data for these maps are of three kinds:

1. *Geological*, being the direct evidence furnished by the extent of marine formations over what is now land, and various indirect stratigraphical and physical considerations.

2. *Palæontological*, being the direct inferences from the former distribution of faunas.

3. *Zoölogical*, being the indirect inferences from the present distribution of faunas.

These are directly in order of their weight, and inversely in order of their completeness.

As this series was drawn up for use in vertebrate palæontology, it represents in the main conclusions in accord with the evidence from fossil vertebrates, in particular from the mammalia. This evidence, so far as it goes, I regard as of generally greater weight than that based upon the past distribution of other groups, since:

(1) The distribution of large terrestrial mammals appears to be more certainly limited by broad oceanic separation than in the lower groups. For while there is a possibility, slight though it be, of the transfer of small animals and plants across extensive and deep oceans by currents, winds or otherwise, and of their obtaining a permanent foothold, and this almost infinitesimal possibility, multiplied by the almost infinite length of geologic periods, becomes a finite quantity which must be reckoned with, yet in the case of large mammals it becomes apparently a strict physical impossibility for this to occur.

(2) The complicated anatomical structure and high degree of differentiation in the mammalia gives more abundant data for comparison and contrast of the structure, and more adequate and certain evidence as to the degree of relationship between different types, than can be obtained in any other group. We are thus more completely assured against the possibility that their classification and arrangement is an arbitrary and not a natural grouping, a defect which if true even to a slight degree, might completely vitiate the conclusions as to palæogeography based upon present or past distribution of animals.

(3) The comparatively rapid rate of the evolution and divergence of mammalian races limits the time within which migrations or changes in distribution may have occurred, and thus not only fixes more definitely the epoch of former continental connections which might have brought about these changes, but reduces the possibility of accidental transference by other means by reducing the time within which it might have occurred.

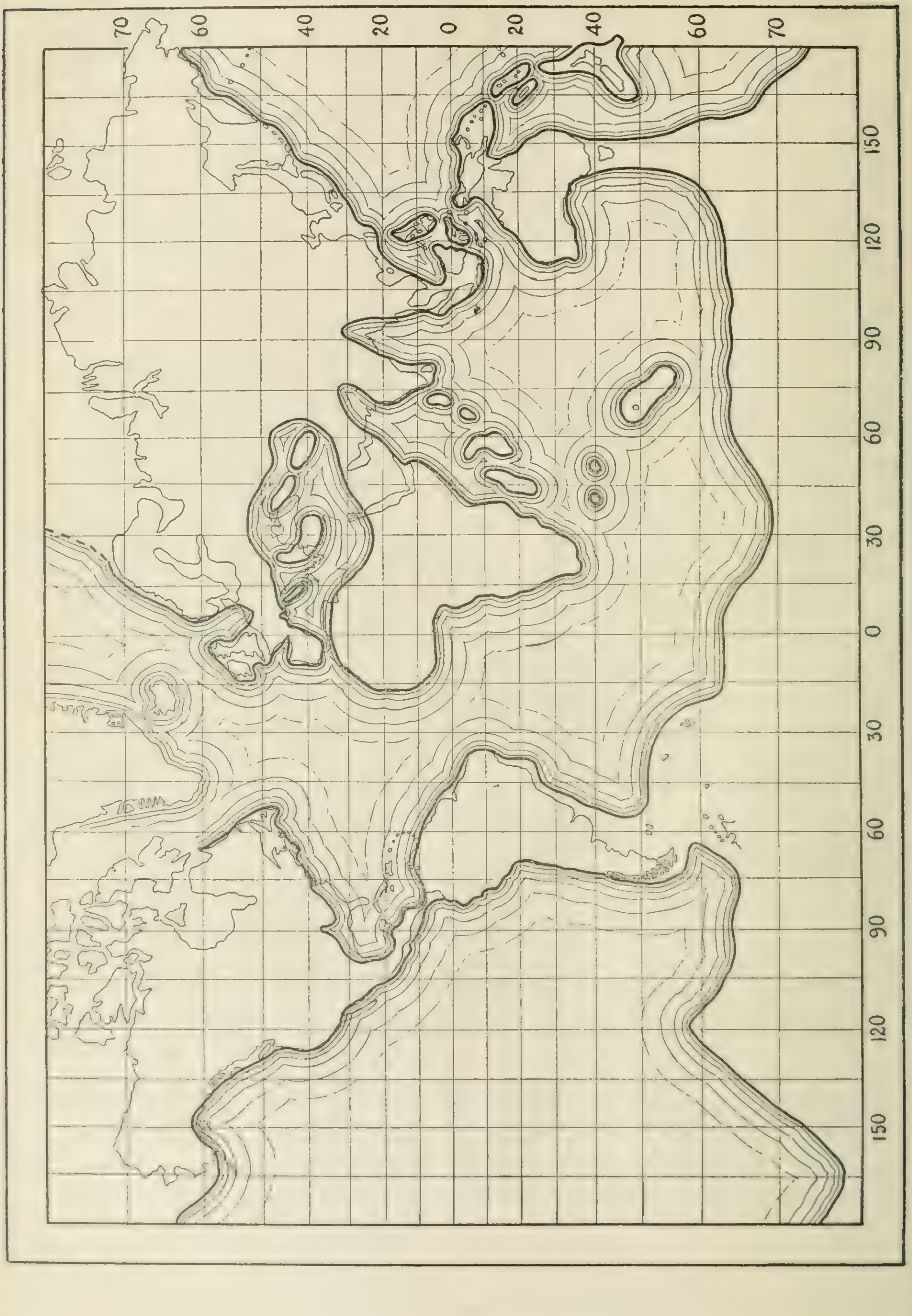
The evidence from present distribution of life is of course vastly more extensive than the palæontological evidence, but its bearing on palæogeography is through its interpretation by theories of classification and evolution which, however strongly supported by detailed morphological structure, are nevertheless theories only until verified by palæontological facts, and necessarily subject to a varying degree of uncertainty dependent upon the extent and force of the evidence and the personal equation of the student. Nevertheless, in the absence of more direct stratigraphic or palæontological data, most of our hypotheses as to former continental connections are based upon this class of evidence.

II. Explanation of Maps.

In the following pages I have attempted to explain the geographic conditions which each map is intended to represent, with some observations upon the relationships of the mammalian faunæ of the successive epochs in its bearing upon continental connections, and have appended under the head of regional notes a variety of quotations and observations in support of the hypotheses of continental changes in each region. The subject is too broad to admit of presenting the evidence even from fossil mammals in any full or detailed manner, and I am not sure that all my confreres in vertebrate palæontology will be willing to indorse some of the generalizations made. I have hardly referred to the evidence from other lines of research, especially in invertebrate zoölogy, although these were considered in compiling the maps. But it is difficult to place the continental changes indicated by evidence from this source at any exact date in the Tertiary, even when they are certainly Tertiary at all. And some of the hypotheses advocated by invertebrate zoölogists involve changes much more fundamental than anything here admitted, while the supporting evidence is not nearly so strong.

1. *Post-Cretaceous.*

During the Cretaceous period there was a great overflowing of the sea over the land areas, the continents were much isolated, climate presumably warm and uniform, and the Age of Reptiles reached its final culmination. At the end of the Cretaceous period there seems to have been a great upheaval of the land in both the northern and southern hemispheres. Great intermigrations took place, the old faunas becoming extinct and new ones appearing in their place. Most of the reptiles became extinct, and mammals for the first time appeared in numbers to take their place. At the opening of the


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

1. Hypothetical Continental Outlines.—Post-Cretaceous.

Tertiary we find the mammalian faunæ of Europe and North America quite nearly related as far as can be judged from the fragmentary remains preserved (see Osborn, Correlation between Tertiary Mammal Horizons of Europe and America, Ann. N. Y. Acad. Sci., XIII, 1900, pp. 1–72.) The Notostylops fauna of Patagonia also contains a number of types more or less closely related to the European and especially to the North American fauna of the Basal Eocene, along with a much larger number of animals more remote from any northern groups. We account for this resemblance by supposing that the three continents were united at the close of the Cretaceous.

At this period also I have placed the union of South America and Australia by way of the Antarctic continent, by which the Marsupials reached both continents, as did also many of the lower animals and plants which are common to these two continents, but not found in the rest of the world. This hypothesis has been advocated by a number of authorities of whom Professor Osborn and Dr. Ortmann are the most recent in date, and I have followed their views most nearly. I have omitted the doubtful connection with Africa which has also been proposed to account for a limited number of peculiar southern forms in that continent, as the evidence for it is not nearly as strong, and the difficulties are much greater (as Osborn has pointed out). If the connection occurred at all it may be supposed to have been at an earlier period.

Evidence from Fossil Vertebrates.

Arctocyonidæ.—This group represents a very early specialized branch of the Adaptive Creodonta (the group ancestral to the true Carnivora of the later Tertiary) which paralleled the modern bears in several respects. The European and American genera are very close, so as scarcely to deserve generic separation. They indicate therefore a common source at a not remote epoch. The group was undergoing rapid specialization as shown by the three stages of its evolution occurring in the Puerco Torrejon and Wasatch formations in America; the likeness cannot therefore be attributed to persistence of primitive characters.

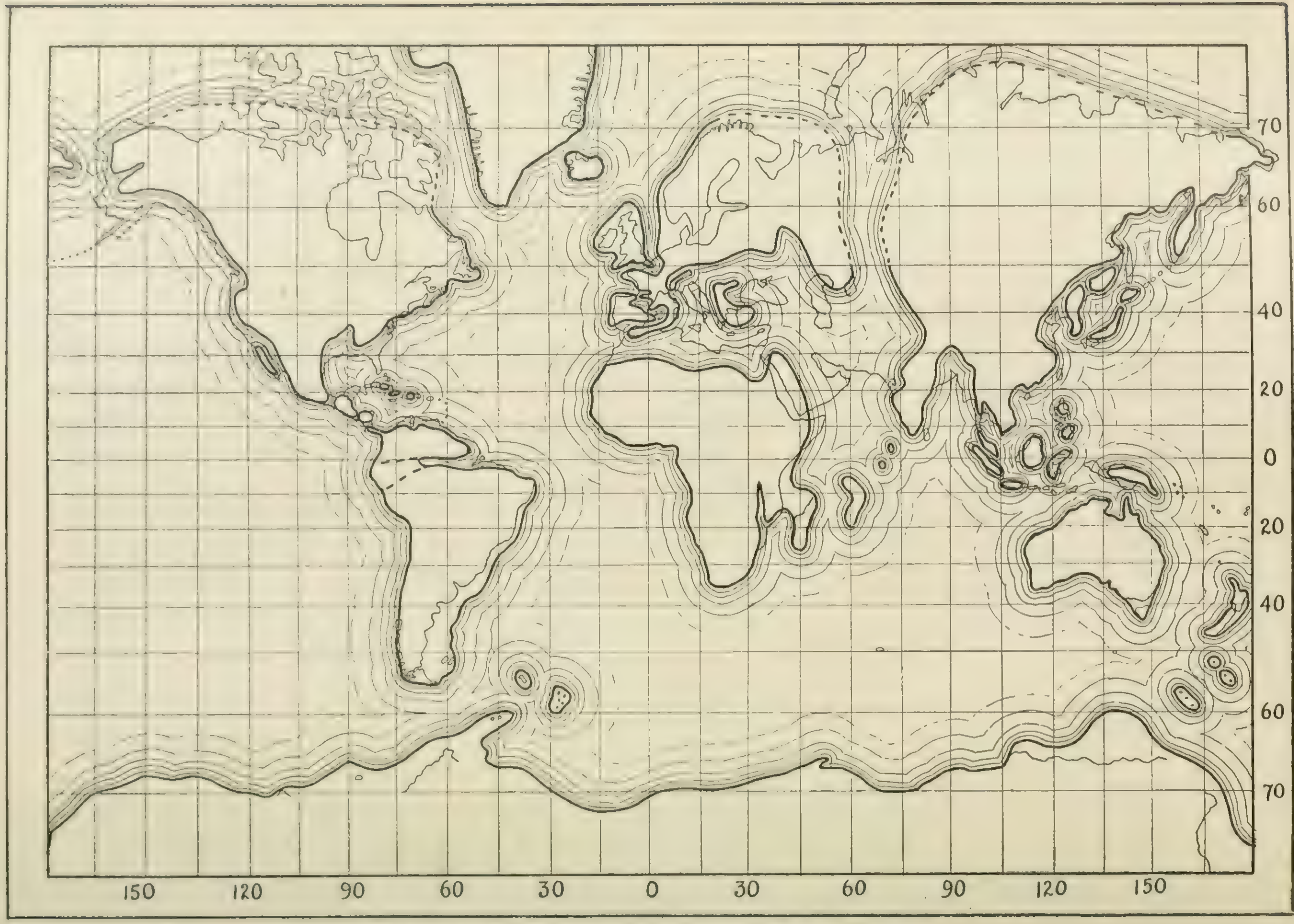
Multituberculata.—Two highly specialized genera occur in North America, *Polymastodon* and *Ptilodus* (including *Neoplagiaulax*). The latter is also found in Europe. In the Notostylops beds are found a number of Multituberculates, mostly less specialized and in much greater variety. The inference is that South America was the home of this group, and that certain of its more advanced types made their way to North America—with difficulty, since there are but two known genera in this country, and these not in the known Patagonian fauna —and thence one of them extended its range to Europe.

Condylarthra.—While there do not appear to be any genera common to the Notostylops and Torrejon or Puerco faunæ, yet several of the South American genera appear to be nearly related, as for instance *Didolodus* to *Ectoconus*, *Notoprotogonia* to *Euprotogonia*, and quite a number of South American genera can be provisionally referred to the Condylarthra, on the ground of their primitive bunodont, tritubercular or imperfectly quadritubercular teeth. Whenever any advance in the direction of crests or crescents appears in the Notostylops fauna, it seems to be invariably after the Notungulate pattern, as exemplified in the posterior cross-crest which connects with the posterior border of the metacone instead of its anterior border, the metaconule usually forming a separate cusp or crescent enclosed between the protoloph and metaloph. Generally the ectoloph is prominent without median rib.

The most serious objection to the scheme of continental connections at the end of the Cretaceous lies in the absence from the known faunæ of the Basal Eocene of the ancestors of the greater part of the later Eocene faunæ. In the Lower Eocene of the northern hemisphere appear for the first time Perissodactyls, Artiodactyls, and Primates, already highly specialized as regards their ordinal characters although only in the initial stages of their family differentiation. These cannot be traced back to the Condylarths, Amblypods, Creodonts, and Edentates of the Basal Eocene; their ordinal characters are too sharply defined and too constant to admit of any near connection. The astragalus, for instance, of a Perissodactyl, Artiodactyl, or Primate is as characteristic and easily distinguished in the Wasatch as in any later formation, and no approximation to it is known among Basal Eocene fossils. We must assume that the ancestors of these orders are not represented in the known Basal Eocene faunæ, and considering their abundance in the succeeding fauna the inference is very strong that they were immigrant groups, coming from some unknown region. But where was this region, and how was it prevented from distributing its fauna to other continents before the Lower Eocene? Presumably it was a northern region, presumably also it was an extensive continent, for the animals which it sent forth were of higher development than the European and North American autocthones which they gradually displaced during the Eocene. The theory of a north polar center of radiation, which explains satisfactorily most of the sudden appearances of new types simultaneously in the Old and New Worlds, does not quite account for this one. In the later radiations the appearance of new groups is heralded in the previous fauna by groups exhibiting an earlier stage of development of the order, and more or less nearly related although not directly ancestral to the new types. They represent earlier offshoots from the developing order. But in the Basal Eocene there is nothing of this kind, for the Artiodactyls and Perissodactyls are not derivable from the Condylarthra, nor the Primates from the Creodonts, except at an epoch much more remote than the end of the Cretaceous. They appear full-fledged, and no Torrejon or Cernaysian groups are approximately ancestral. They must therefore have undergone a long course of evolution in some region cut off from Europe and North America. Since the close relations between their Basal Eocene faunæ indicate that these two continents were connected at the end of the Cretaceous, and their most probable connection was by way of the north polar region, the isolated continental region in which the Perissodactyls, Artiodactyls, and Primates developed must have been elsewhere than circumpolar, and the most plausible solution would seem to be that Asia was not connected with the circumpolar land until the Lower Eocene, and that its vast extent furnished an arena for evolutionary struggles, which then, as in later epochs, gave room by its greater magnitude for development a larger number of dominant types than any other part of the world. I have not ventured to embody this idea in the map, as the evidence seems at present inadequate.

2. *Eocene.*

During the Eocene the sea again invaded the continental areas, insulating the six great land masses of North America, South America, Australia, Africa, Asia, and probably Europe. Each continent then developed its peculiar fauna, independent of all the others. This was probably an epoch of warm, moist, and uniform climates, dense forests prevailing over large areas, and the animals were mainly adapted to these conditions. In North America the Uintatheres, the Camels, the Titanotheres, the Horses, and certain peculiar types of Rhinoceroses were among the large animals; in South America the Pyrotheria, Toxodonts and Typotheres, Astrapotheres, Litopterna, Edentates, and other groups of peculiar animals now almost all extinct. Many of these had probably commenced their differentia-


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

2. Hypothetical Continental Outlines.—Middle Eocene.

tion during the Cretaceous period, either in South America or Antarctica, and a few of the Edentates may have come up into North America at the close of the Cretaceous and given rise to certain aberrant Edentate forms found in the Eocene of this country (*Metacheiromys*, Stylinodontidæ).

The Eocene mammals of Africa, only discovered within the past two or three years, were equally peculiar, and among them were the ancestors of the Elephants and the Conies and various groups of animals which are now extinct.

In Europe were Lophiodons, Palæotheres, and other large mammals, but the greater part of this continent was at this period, and continued to be through most of the Tertiary, a shifting archipelago of islands whose relations to each other and to the Asiatic continent were continually changing, and the true course of the evolution of its animals is a much more complicated problem than in the other continents.

The Eocene animals of Asia and of Australia are not known, but it may be inferred from the later faunas that each continent was developing its own peculiar mammals, in Australia, the Marsupials, while in Asia may have been evolving the ancestors of most of the more modern groups of mammals.

The map represents the supposed conditions of isolation which favored the development of distinct faunæ in each of the great continental regions. These would seem to have reached their culmination in the Middle Eocene. The Lower Eocene fauna of Europe and North America, derived in part from the pre-existent faunæ of those continents, and in part, as we have seen, from an unknown common source, possibly Asiatic, were a great deal alike, and several genera are common to both regions (*Coryphodon*, *Pachyæna*, *Palæonictis*, etc). But from this time onward the two faunæ developed on divergent lines and no further interchange or migration took place until the end of the Eocene. In America the Perissodactyls developed into *Palæosyops* and *Hyrachyus*, *Helaletes*, *Isectolophus*, and *Orohippus*, in Europe into *Lophiodon* and *Palæotherium*, *Lophiotherium* and *Pachynolophus*. In America the Amblypods developed into *Uintatherium;* in Europe they disappeared. In America the early Hyænodonts died out; in Europe they developed into *Pterodon* and *Hyænodon*. In America the early Lemurs developed into *Notharctus* and the Anaptomorphidæ and Microsyopidæ; in Europe into the Adapidæ and Necrolestidæ. And so on to the end of the chapter. A number of supposed American genera are recorded from the Middle

Eocene beds of Egerkingen, but it should be remembered that these are Lower Eocene, not Middle Eocene genera (although some also persist into the Middle Eocene of this country), and are mostly founded on fragmentary specimens of uncertain identification. Hence they may be taken to infer a connection between North America and Europe in the Lower Eocene, and the persistence in Europe and in part in North America of certain genera characteristic of the earlier age, after the connection had disappeared.

In South America we have a much more complete isolation. The Notostylops fauna of the Basal Eocene (Cretaceous according to Ameghino) contains only a small element which suggests any near relationship with the northern faunæ. In the succeeding faunæ many new elements appear, but none of them seem to be derived from the earlier Eocene faunæ of the northern continents. Edentates and Rodents are the most important, but their relationship to the Edentate and Rodent elements of the Northern faunæ is evidently remote from their first appearance and we must attribute any common origin to an epoch not later than the end of the Cretaceous. The new elements, together with the old, developed upon parallel lines with the Eocene faunæ elsewhere but were entirely independent of them through the Eocene, Oligocene, and Miocene epochs. The closeness of the parallelism speaks for similar climatic conditions and changes in both northern and southern hemispheres, and is a strong argument for the correctness of the correlation here adopted. As is well known, the most prominent and ablest of the Argentine palæontologists advocate a much greater age for the Notostylops and Pyrotherium faunæ than is generally admitted in Europe and North America, resting their claim especially on the discovery of Dinosaur remains in the same formations, and, in the case of the *Notostylops* beds, in close association with the fossil mammals. The geological and palæontological evidence against this view is presented in Ortmann and Hatcher, and important confirmatory evidence is given by M. Tournouer. Dr. Ameghino has recently replied at some length to the criticisms of the first two writers and maintains very strongly his original view, that the *Notostylops* and *Pyrotherium* faunæ are Lower and Upper Cretaceous respectively.

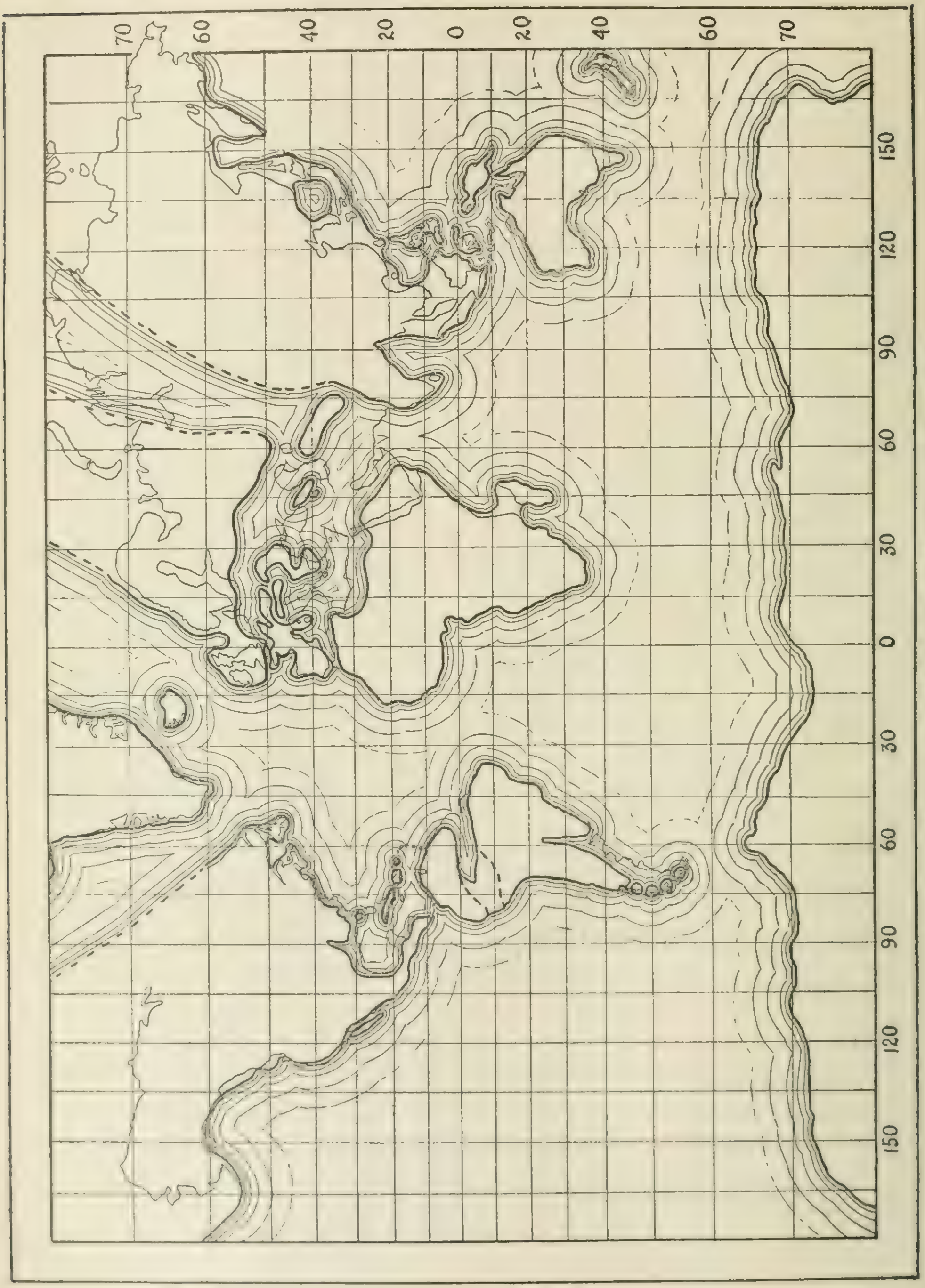
The Upper Eocene fauna of Africa, recently explored by Andrews and Beadnell, shows evidence of a similar long period of isolation for this continent and points to similar physical and climatic conditions as indicated by a fauna analogous to those of the Eocene in North America, Europe, and South America. That this isolation had recently come to an end is shown by the presence among a variety of utterly strange types of mammals, which must have developed in an isolated continent, of the European Upper Eocene genus *Pterodon*. But the evolution of the gigantic and highly specialized *Arsinoitherium*, *Barytherium*, the early stages of the Proboscidea, and the large and remarkable Hyracoid forms, calls for a long period of isolation, which must have begun not later than the end of the Cretaceous. Certain features of the modern fauna of South Africa appear to indicate a remote connection with the other southern continents, and there are some features about the Eocene fauna which would appear to show that it is, in part at least, more nearly related to the South American Eocene faunæ than to those of the Holarctic region. If so, we must modify our ideas to the extent of connecting Africa with the southern continents at the end of the Cretaceous, either directly with South America or via Antarctica.

The Eocene fauna of Asia is entirely unknown. But it may well be that in this region were evolved many or most of the new types which appear simultaneously in the later Tertiary epochs of Europe and North America, in successive waves of migration from some outside source, and in general overcome and supplant the native faunæ more or less completely. If this be so we may look to the exploration of the arid regions of Central and Eastern Asia as likely to yield more light on the true and direct phylogeny of most modern animals than all that we have hitherto known. The opening up of the Chinese Empire to modern scientific research will perhaps be the preliminary to an immense advance in palæontological knowledge.

The whole Tertiary history of Australian mammals is a blank as yet, but there is a fair prospect of its being filled by research in the arid central regions of that continent. We know almost equally little of the Tertiary mammals of the East Indian and Melanesian islands, and unfortunately are not likely to learn much, since the moist climate and dense vegetation of these regions does not favor the exposure of great areas of Tertiary land deposits, if such exist there.

3. *Oligocene.*

With this epoch begins the emergence of the continents from their Eocene submergence, and a large amount of migration from one to another follows. The European, Asiatic, and North American land-masses became connected, and a great invasion of a new fauna into North America and Europe took place, coming presumably from


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

3. Hypothetical Continental Outlines.—Middle Oligocene.

Asia. Whether the connection between the Old World and North America was by way of Alaska or across the whole breadth of a great Polar continent is uncertain.[1] It is not probable that it was via Greenland, for a deep sea intervenes. It resulted in a marked approximation between the North American and European faunas. While in the Middle and later Eocene there is no genus of mammals common to the two continents (a few supposed identifications are based on exceedingly fragmentary material and in some cases I know them to be wrongly made), in the Oligocene there is quite a number of common genera, including *Titanotherium*, *Anthracotherium*, *Elotherium*, large highly specialized Ungulates which could not have passed from one to the other except by a land bridge.

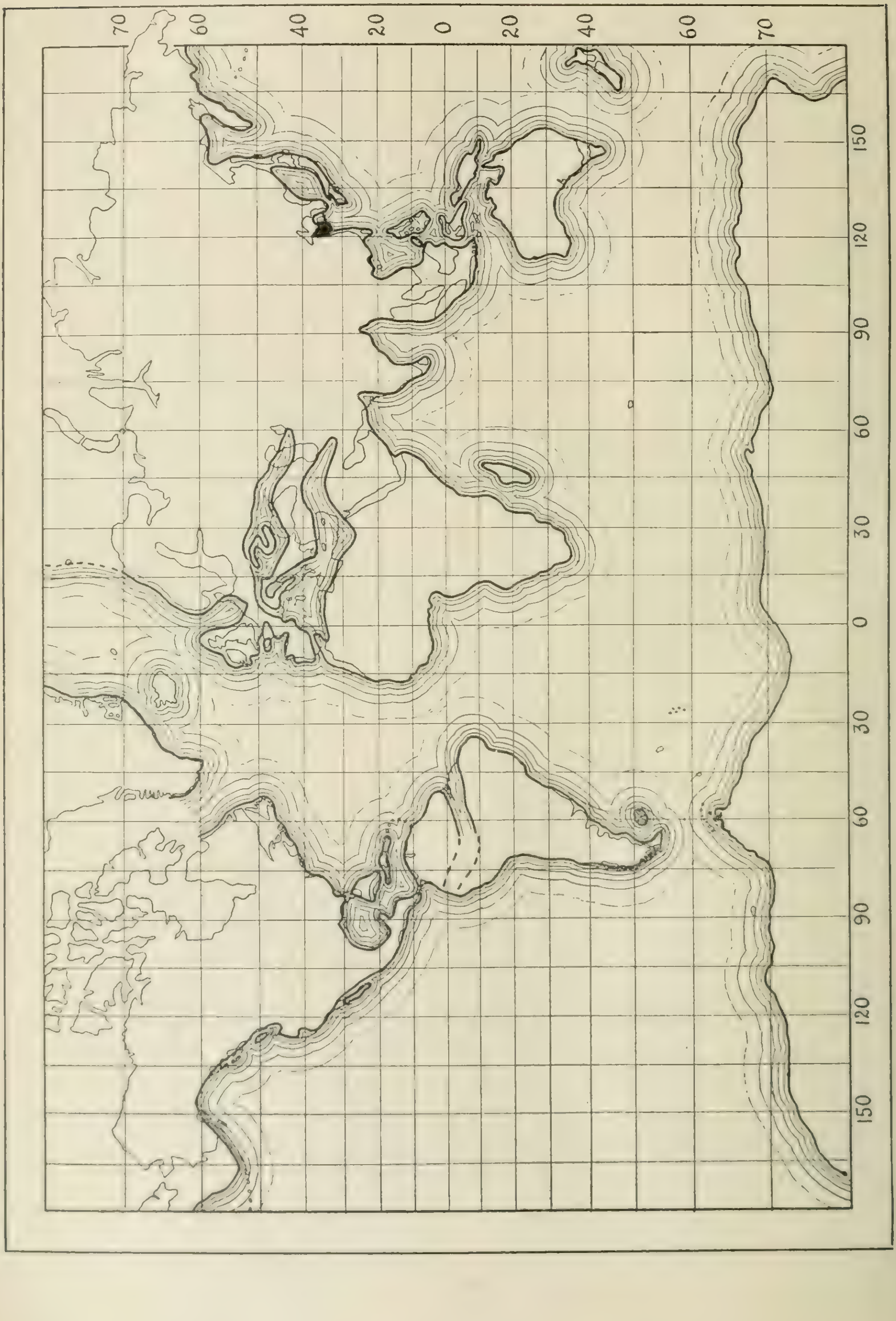
The new faunæ are in part outgrowths from the Eocene faunæ of one or the other continent, but a large part cannot be traced directly back into known Eocene types, although in most cases approximate ancestral representatives may be found. These new types may be regarded as in part descended from unknown elements in the Eocene faunæ, but in part as immigrants from some other region—Asia or the Arctic regions. Through the Oligocene the tendency would seem to be rather for divergence of the faunæ than any further interchange. In Africa the contact at the end of the Eocene does not seem to have persisted long enough to introduce African mammals into Europe, or to destroy the native Ethiopian fauna by countermigration from the north, since certain types at least continued. The three southern land masses remained separate and distinct, and went on developing their peculiar faunas.

4. *Miocene.*

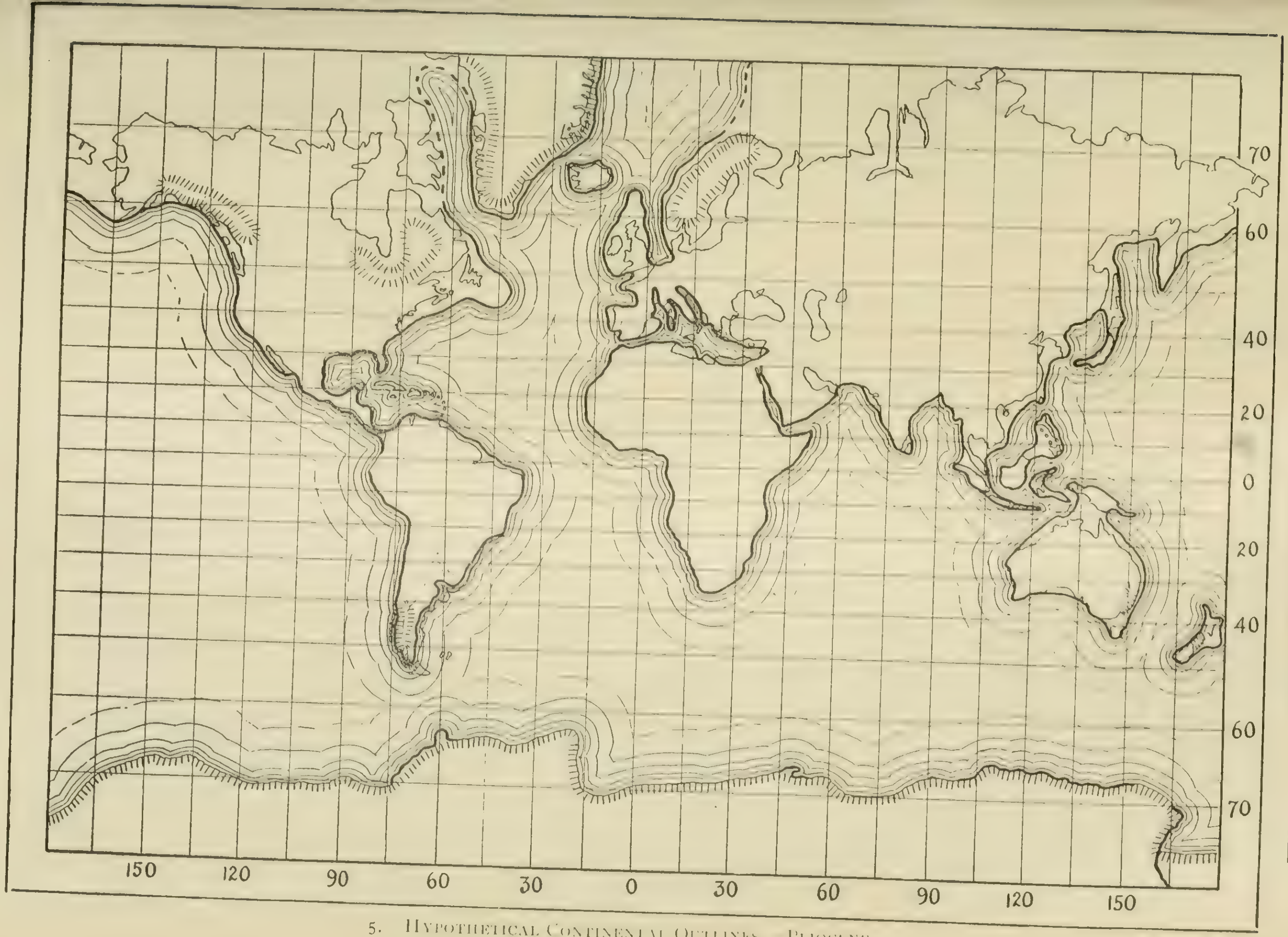
In the Miocene the emergence of the continents had progressed further, and especially the great central sea of Europe and southern Asia had been much reduced in size, and Africa united with the mainland, allowing the Proboscideans to invade Europe and North America. Other unknown changes of climate or geography, quite probably the commencement of cold climate at the poles, caused new invasions of a common fauna into the European and North American areas. Australia still remained separate, and so probably did South America, although it is not certain that the separation was at Panama.

---

[1] It would appear from more recent research that a considerable part of the Arctic Ocean is of great depth. If, then, we apply here the theory of the comparative stability of the deep oceans during the Tertiary period, to which these maps in general conform, the polar connections of the northern continents must have been much more limited than is represented on the maps, perhaps chiefly by way of Alaska.


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

4. Hypothetical Continental Outlines.—Miocene.


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

5. Hypothetical Continental Outlines.—Pliocene.

Possibly, as indicated, it was further south, in the region of the Amazon and across the Andes and Ecuador.

At this epoch may have occurred the union of Borneo, Sumatra, and Java with the Asiatic mainland, enabling the animals of Asia to populate these islands. They may or may not have been united during the previous epochs; of this I can get no evidence.

5. *Pliocene.*

The Pliocene was an epoch of great elevation of all the continental land masses, greatest apparently in Europe and in eastern North America. By this time South America must have become united to the northern continent, and an interchange of mammal faunas took place, various South American animals appearing for the first time in the Pliocene of North America, while a great invasion of northern animals into South America began, rapidly displacing the native types of that country.

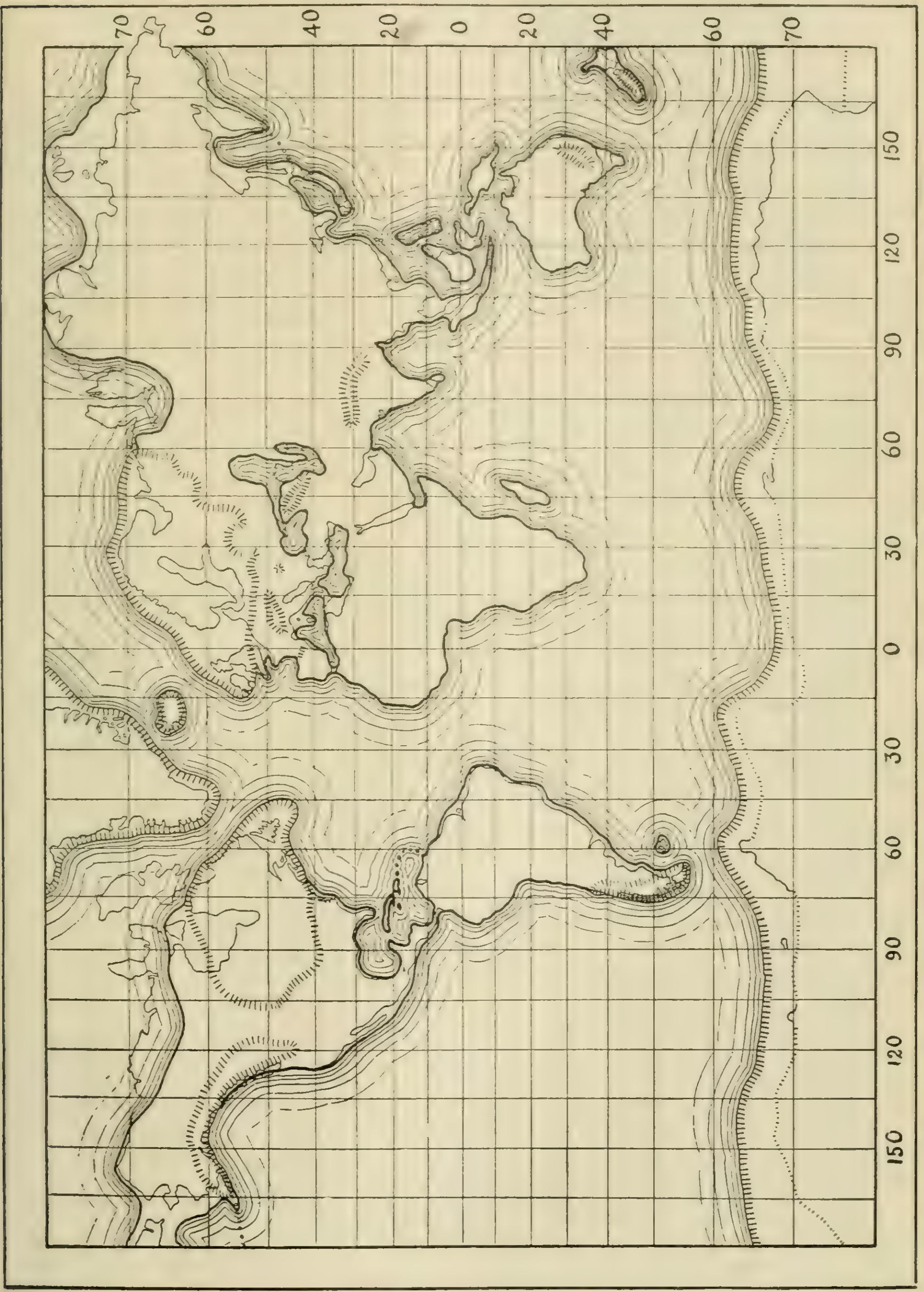
Australia remained separate from the Asiatic mainland, although probably united with New Guinea and Tasmania. Borneo seems to have separated off from Asia at an earlier time than Java and Sumatra, perhaps at this epoch; on the other hand it may have been united with the Philippines, which may be supposed to have been connected with Asia at a former epoch.

Probably the great elevation of northern Europe and northeastern America, and the oncoming of the cold climate in the polar regions may have initiated the glacial epoch, and covered Greenland, Norway, and Labrador with sheets of ice.

6. *Pleistocene.*

The most striking feature of this map is the culmination of the glacial epoch, the whole of northeastern America, as far south as the latitude of New York, and all of northern Europe, being buried in ice, while less extensive ice masses came down from the mountains of Alaska and British Columbia, the Alps, the Caucasus, and the Himalayas. Probably the glaciers of Greenland were more extensive than now, reaching beyond the borders of the land on all sides, and sweeping out of existence whatever life may formerly have inhabited Greenland and Iceland.

There is clear evidence of considerable glaciation in the southern end of South America, in New Zealand and in Australia during either Pliocene or Pleistocene time, so that we must suppose that the southern hemisphere suffered under similar conditions, and that the northern


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

6. Hypothetical Continental Outlines.—Early Pleistocene.

Ice Age was not accompanied, as has been supposed by some writers, by a warm equable south polar climate. In other words the glaciation of the two hemispheres was simultaneous, not alternating. I have therefore indicated an extension of the Antarctic polar cap beyond its present limits. It is even now much more extensive than the northern ice caps ever were; this difference is probably because the high land of the Antarctic regions centered around the pole, while in the Arctic region there was a great depression of most of the land areas around the pole, and the warmer water from the tropical regions was admitted through the North Atlantic open sea. The three areas where high land of wide extent did exist were heavily ice-capped.

Aside from the great glaciation, the chief points of interest in the Pleistocene are the union of the Black Sea, Caspian, and the Sea of Aral into a huge lake, the Hyrcanian Sea, and the separation of the Mediterranean into two closed seas. New Guinea had perhaps become a separate island by this time.

7. *Modern.*

The continental outlines of modern time are not very different from those of the Pleistocene. The great ice-caps of Europe and North America had disappeared, the glaciated regions sinking somewhat below their present level, and then rising again. Ceylon has become separate from India, Sumatra and Java from the Malayan peninsula, and Tasmania from Australia; but in none of these islands has the separation been long enough to evolve a very distinct fauna. The great Hyrcanian Sea has shrunk to small proportions. The separation of the Japanese and Philippine archipelagoes and the two islands of New Zealand, may be supposed to have occurred since the Ice Age.

The light lines in this map represent the line of 1000 feet depth and are in general the real borders of the continents, for beyond this line in almost all cases the ocean depth increases rapidly to many times that amount, and the parts of the ocean over a thousand feet deep are in almost every case over ten thousand.

It may be seen that the most of the Arctic ocean is very shallow, really forming a part of the continents of Asia and North America, but that a deep strait extends up on either side of Greenland. New Guinea and Tasmania are a part of the Australian continent; Sumatra, Java and Borneo of the Asiatic continent. A wide area of the shallow sea extends east from Patagonia and the continental border of northeastern North America extends as far east as the Banks of Newfoundland. Alaska and Asia are connected by shallow water, England and Ireland are a part of the European continent mass, Japan of the Asiatic, while the Philippines connect with Borneo, and so on. On the other hand, New Zealand, Madagascar, Celebes, Iceland, and many smaller oceanic islands, have no shallow water connections. These relations are one principal guide in constructing former geologic connections, as it is evident that a slight rise in the land would unite for instance Sumatra to Malacca, while it would take a great geological convulsion to unite New Zealand to Australia, and such an upheaval ought to leave recognizable traces.

III. Regional Notes.

Europe and Adjoining Regions.

For the European region I have made no attempt to consult the original authorities, but have adopted the views outlined by de Lapparent in his 'Traité de Géologie,' edition of 1900. This section has been more thoroughly studied than any other, and there is a great mass of literature bearing on the subject. The European continent, however, presents a very complicated problem, and considerable parts of the outlines adopted must be admitted to rest on pretty slender evidence. But to sift and criticise this evidence so as to eliminate the less well founded hypotheses would involve an amount of work which I am not able to undertake, so that it seems best to take de Lapparent's outlines as they stand.

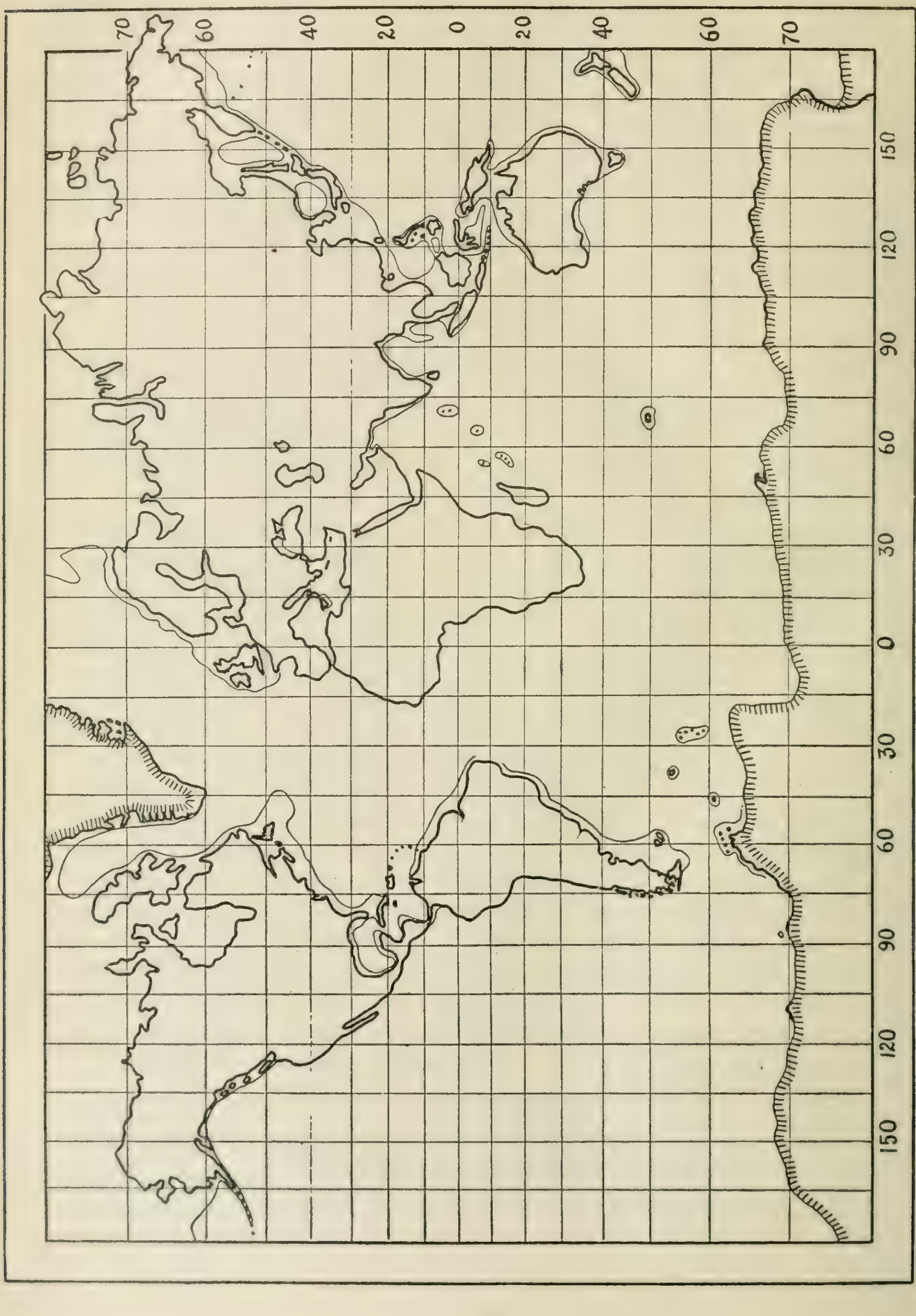
Eastern North America and Central America.[1]

Dr. Dall is my chief authority for the general conditions along the Eastern and Gulf coasts of the United States and the Antillean region. The views propounded by Dr. Spencer, while they would supply a very satisfactory solution of certain difficulties in regard to the present and past distribution of the mammalia of the Antilles, are not accepted by the majority of authorities on this region, and involve such extensive movements of elevation and depression that they need the strongest and most convincing evidence to confirm them. Dr. Dall observes:

"I am entirely unable to accept Dr. Spencer's hypotheses; while admitting many of the facts he brings forward, I am convinced that they admit of some other explanation. We find in the Oligocene of Bowden landshells belonging to groups peculiar to and now inhabiting

---

[1] Chief Authorities:—Dall and Harris, Correlation Papers. Neocene. U. S. Geol. Surv., Bull. No. 84, 1892. Dall, W. H., Geological Results of the Study of the Tertiary Fauna of Florida. Trans. Wagner Inst., Vol. III, part vi, 1903. Hill, R. T., Geological History of the Isthmus of Panama and Portions of Costa Rica. Bulletin Mus. Comp. Zoöl., XXVIII, pp. 151–285, June, 1898.


70
60
40
20
0
20
40
60
70
150
120
90
60
30
0
30
60
90
120
150

7. Modern Continental Outlines, showing the line of 1000 feet depth.

the island of Jamaica, which is sufficient evidence that since the era during which the Bowden marl was deposited the island has never been entirely submerged. With Cuba it may be different, although I can hardly bring myself to believe that the peculiar landshell fauna which is so characteristic of that island can have been evolved since the Pleistocene . . . but that any considerable part of the island has been submerged since the beginning of the Miocene seems extremely doubtful. . . . According to Mr. Vaughan's observations the great mass of the Tertiary limestones of Cuba are middle and upper Oligocene. . . . The Vicksburgian and the Miocene are alike absent, no positive identification of Pliocene beds has been made, and the Pleistocene reef rocks do not occur above the sea at a greater height than thirty or forty feet.

"The, on the whole, remarkable horizontality of the Floridian strata indicates a freedom from violent changes of level from the time the Peninsular limestone first emerged from the sea. Landshells in the Ocala limestone show that then dry land existed. South of the Suwannee Strait, closed in late Miocene times, there is no evidence of subsequent submersion to any serious extent. Two gentle flexures run parallel with the peninsula, having the lake district between them; a tilting of, at the most, thirty feet, up at the east, down at the west, which may have been contemporaneous with the flexures; and, for the rest, very slow and slight but probably nearly continuous elevation never exceeding one hundred feet and perhaps less than half that, with dry land and fresh water lakes constantly existing since the Ocala islands were raised above the sea; such is the geological history of the Florida peninsula. . . .

"On the Gulf and southeast Atlantic coast of North America no marked stratigraphic break has been established between the Eocene and Oligocene series. . . . Nevertheless if the invertebrate fauna is taken into account and all allowances made for the existence of a few indications of transition, the change in the fauna is so marked that physical changes elsewhere must be assumed to account for it. . . . The thickness and extent of the Vicksburg limestone, stretching from the Floridian region to Costa Rica, and its singular absence from the Antilles, so far as yet identified, taken together with the comparative thinness of the post-nummulitic Oligocene on the Gulf coast and its enormous development in the Antillean region, the north shore of South America, and the region of Middle America south of Mexico, suggest that during the period indicated there was first a depression of the continental border coincident with elevation of Antillean lands, while during the period of the upper Oligocene these conditions were reversed, the continental sea margin being brought near to, and even, at the Ocala Islands, above the surface of the sea, while a depression of Antillean lands and Middle America permitted the formation of those great bodies of marine limestone and marls for which the upper Oligocene of those regions is so remarkable. . . . [At the close of the Oligocene] the Middle American highlands, the larger Antillean islands, and the peninsular island of Florida were uplifted, the two Americas united, and vast physical changes consummated. Coincidently at the north the boreal coasts were gently depressed and the waters of the Miocene sea extended over the ruins of the Oligocene forests. . . . Some change along the northern coast permitted an inshore cold current to penetrate the Gulf, depositing on the floor of the shallow Suwannee Strait separating the island of Florida from the continental shore, a thin series of Miocene sediments. . . .

"The movement in elevation which ushered in the Miocene continued, probably, during its entire term. It amounted in Costa Rica, according to Gabb, to several thousand feet, and permanently united the two continents.

"I concur with Hill in the belief that whatever changes of level may have taken place since, no discontinuity of the link between North and South America from the Miocene to the present time is probable, and certainly none amounting to a free communication between the two oceans.

"At the termination of the Miocene epoch Florida became united to the continent."[1]

Dr. Dall explains the fact that the Texas Miocene fauna is of a different stamp from that of the eastern Gulf and Atlantic coasts, but nearly allied to that of the Pacific coast, by the supposition that the fresh water of the Mississippi pouring into the Gulf served as a barrier to the westward migration of species of marine invertebrates.

Dr. Hill summarizes his views in regard to the Central American isthmus as follows:

"There is considerable evidence that a land barrier in the Tropical region separated the two oceans as far back in geological history as Jurassic time, and that that barrier continued throughout the Cretaceous period. The geologic structure of the Isthmus and Central American regions, so far as investigated, when considered aside from the paleontology, presents no evidence by which the former existence of a free communication of oceanic waters across the present tropical land barriers can be established. The paleontologic evidence indicates the ephemeral existence of a passage at the close of the Eocene period. All lines of inquiry—geologic, paleontologic and biologic—give evidence that no connection has existed between the two oceans since the close of the Oligocene. This structural geology is decidedly opposed to any hypothesis by which the waters of the two oceans could have been connected across the regions in Miocene, Pliocene, Pleistocene, or recent time."[1]

---

[1] Trans. Wagner Inst., III., pt. vi., pp. 1545, 1547, 1549, 1550.

In the above summary Dr. Hill takes no account of the evidences from fossil land vertebrates, nor does he mention them in his discussion of the evidence on which his conclusions are based. Nevertheless they give some of the most important data on which the question should be decided, for the stratigraphy is as yet too imperfectly known to be decisive on all points. In the main the evidence from fossil mammals very strongly confirms his conclusions, but points to a longer duration of the early Tertiary break between the two continents than he is disposed to allow. The Middle Miocene (Santa Cruz) land vertebrate fauna of Patagonia and the Middle and Upper Miocene fauna of the Western States are among the best known and most extensively explored and studied of all our fossil faunas. Each points to an absolutely independent development which must have endured for a long time. No South American types appear in North America, no North American types in South America, until the beginning of the Pliocene. In the Pliocene (Blanco) a number of South American types appear, for the first time, and continue to appear through the Pleistocene, a few still existing. At the same epoch in the South American formations (Araucanian) appear for the first time North American types, and they increase in proportionate numbers until recent times, gradually displacing the autochthonic types, most of which are now extinct.

It is hardly possible to suppose that if land mammals had free communication between the northern and southern continents as early as the close of the Oligocene, not a single species extended its range from one to the other continent until the beginning of the Pliocene, but that a large interchange of faunas then suddenly commenced. Stable conditions would not account for such a fact, for the conditions were not stable, as is shown by the rapid evolution of many mammal races and the immigration of many new types in the North American Miocene. Some barrier there must have been; it could hardly have been a climatic barrier, for that would have hindered the interchange of faunas during later epochs as well as in the Miocene. No other hypothesis but that of a continuance throughout the Miocene of the separation of the continents appears to be applicable. The entire continuity of the isthmus after the Oligocene, rests on the absence of Pacific types in the marine Gulf sediments of the Oligocene and Miocene epochs. How far this fact might be explained away by differences in temperature of the waters, or other limiting conditions, I am unable to say. But most land mammals are certainly much less subject to limitation of range from conditions of temperature or climate than are marine invertebrates, and it appears to me that their evidence ought to have much greater weight, when it is derived from sufficient data, as in this case it is.

---

[1] Bull. Mus. Comp. Zoöl., XXVIII., p. 270

It is quite true, as Dr. Hill remarks, that the separation of the continents need not have been at Panama, but elsewhere along the Central American strip. Dr. Ortmann has suggested, as a mode of reconciling the conflicting evidence from vertebrates and invertebrates, the adoption of Von Ihering's hypothesis, that South America was divided into two areas during most of the Tertiary period, by a strait reaching up the present Amazon valley and through to the Pacific across what is now one of the highest and broadest parts of the Andes. This would more or less reconcile the evidence from our present knowledge of the mammalia, as no Tertiary mammal fauna is known from the area north of the Amazon. I do not know whether the distinctness of the Tertiary invertebrates of the Pacific and Gulf coasts would accord with an oceanic connection across South America much better than with one through Central America. But the hypothesis involves such a staggering amount of elevation since the beginning of the Pliocene, that one would hesitate to accept it on the palæontological evidence alone, and the stratigraphic proof appears to be at present inadequate. If we knew the Tertiary and especially the Miocene faunas of Venezuela and Guiana better the hypothesis could be tested by them; without that, it is too radical for the present view.

The authors of the Neocene 'Correlation Papers' summarize their conclusions on this subject as follows:

"Toward the end of the Eocene it is certain that the process of elevation had proceeded far enough to raise above the sea part of the summit of the western anticline of Florida, if not of both the great Floridian anticlines. . . . At the end of Eocene time the continental shore line appears to have bordered the Atlantic in a generally northeast and southwest direction from the Hudson to the Chattahoochee. . . . There was a well marked indentation in southeastern Georgia, while from the vicinity of the Chattahoochee the shore rounded to the west, northwest, and north, forming the eastern coast of the great Gulf of Mississippi . . . which extended to the meeting of the Ohio and Mississippi rivers. . . . From this vicinity the shore extended in a southwesterly direction, without striking irregularities, to the Rio Grande. At the culmination of the Eocene a movement of elevation seems to have taken place, which, . . . raised this shore to an extent which gave the continental margin a notable addition to its area. . . . The most important additions in point of area were to the southwest and on the shores of the Gulf of Mississippi. The area between the central Florida banks and the mainland was not elevated above the sea. . . . After the end of the older Miocene, the Floridian banks and their associated islands still remained insulated from the continent. . . . Before the termination of the marine Pliocene the permanent connection of the peninsula [Florida] with the continent was accomplished." [1]

Dr. Becker summarizes the conditions during the Tertiary thus:

"Both the Sierra Nevada and coast ranges were above water during the interval between the Knoxville and the Chico epochs. Both ranges sank just before the beginning of the Chico, admitting the ocean over a great part of the coast ranges and over considerable areas at the base of the Sierra. Both appear to have risen partially and gently before the Tejon (Eocene) particularly toward the north. . . . A slow subsidence would seem to have taken place before the Miocene. . . . indicating for the Miocene a lower general level than during any preceding epoch. During the Pliocene very little of either range was below water." [2]

Greater Antilles.[3]

Dr. Hill's (*l.c.*, p. 224) results are summarized as follows:

"The land débris constituting the Eocene strata throughout the islands testifies the pre-existence of extensive Cretaceous land areas. There was a profound regional subsidence in late Eocene and early

---

[1] Dall and Harris, Neocene of North America. U. S. Geol. Surv;, Bull. 84. pp. 181, 182 186, 191.

[2] Becker, Tertiary and Post-Tertiary Changes of the Atlantic and Pacific Coasts. Bull. Geol. Soc. Am., 1891, p. 323.

[3] Chief Authority:—Hill, R. T. Geological Reconnoissance of Jamaica. Bull. Mus. Comp. Zoöl., Vol. XXXIV, 1899, pp. 1-226.

Oligocene time, which submerged all but the highest tips of the Antilles. . . .

"In late Oligocene or Miocene time there was a tremendous orogenic movement which resulted in uplift whereby many of the islands were connected with each other, and possibly an insular southern portion of Florida, but not establishing land connection with the North or South American continents.

"In Miocene or early Pliocene time the islands were severed by submergence into their present outlines and membership, which they have since retained with only secondary modification.

"In Pliocene and Pleistocene times there have been intermittent periods of elevation . . . but not sufficient to establish land connections or to restore the islands to the heights and areas of Mid-Tertiary time."

Dr. Spencer's much more radical views in regard to this region are stated in the following paragraphs. The objections to adopting them have already been quoted.

"During early Eocene a portion of the West Indies was elevated, but this elevation does not seem to have extended to the adjacent continental area. During the later Eocene and most of the Miocene period only a few islands appear to have existed in the seas of the West Indies and Central America. . . . In the Miocene period there appears to have been a great subsidence of many portions of the Antillean and continental regions. . . . Throughout most of the Pliocene period there was an extensive elevation and development of the Antillean region. In part this elevation may have commenced in the later Miocene. . . . The great continental elevation in some regions [Barbadoes, Anguilla, Trinidad] appears to have commenced at the end of the Miocene and in other places in the early Pliocene period [Cuba, San Domingo, Jamaica, Florida], but the Tertiary seas were being gradually restricted, from the early Eocene times, along the continental margin. . . . The geologic development of Central America is yet somewhat hypothetical. That the drainage was towards the Pacific is highly probable if not certain, since the characteristics of the adjacent portions of the ocean bed indicate a continuation of the Gulf and Caribbean valleys and plains; but in the great oscillations of the land from abyssmal depths to continental elevations of 8000 or 12,000 feet, some insular masses doubtless rose into prominence. Such heights would refer mostly to the region of the Greater Antilles and the adjacent continents, for the Gulf and Caribbean plains must have been low. . . . The surveys of the sea of Honduras are much less complete than those of the Gulf of Mexico, but they are sufficient to indicate that a great portion of that sea was shrunken to narrow limits if not entirely drained. . . .

"The Matanzas epoch [about equivalent to the Lafayette, Upper Pliocene] represented a general submergence below the present altitude, not only of the coastal plain from 100 to 1000 feet but that the Antillean lands at the end of the Pliocene period were depressed so that only a few islands remained at altitudes from 100 to 1100 feet lower than to-day. . . . After the deposition of the Matanzas limestone and the Lafayette loams the continent rose to a great elevation. The present lands of the West Indies and the adjacent parts of the continent stood quite as high, if not higher than during the Pleistocene elevation. Whether the elevation was great enough to completely drain the sea of Honduras (as the Caribbean sea) cannot be told at present. The great altitude of the Antillean land is no longer a question. . . . The subsidence (in the later Pleistocene) which followed the earlier Pleistocene elevation. . . . depressed all of the greater Antilles, Central America, and the coastal margins of the continent from about 25 to 500 or 700 feet lower than now. This subsidence greatly reduced the size of the larger West Indies and Central America; it also made the coast of the northern continent recede 100 or 150 miles and drowned most of Florida. . . . At the close of the Pleistocene the Antilles rose from 150 to 200 feet above the modern altitude . . . the floor of the Antillean seas . . . were low lands extending to the Pacific side of Central America [during the Pliocene elevation] but it is to be remembered that this inference is tentative only. . . . The modern islands of the West Indies formed an elevated plateau bridge between the two Americas during the two epochs of elevation, namely in the Pliocene and Pleistocene periods. . . . The Pacific contours do not support the hypothesis of a post-Miocene extension of the sea of Honduras to that ocean, as do those of the Gulf of Mexico and Caribbean sea. It would appear that the latter basins drained directly into the western ocean in the earlier part of the Pleistocene period. The late Pliocene depression admitted the Atlantic currents with greater depths than at present to the Antillean seas. The Pacific waters probably had access by one or two straits with depths of about 200 feet . . . Panama and Nicaragua. With the earlier Pleistocene elevation the drainage of the Antillean continent was again restored to the Pacific ocean between the barriers of Central America which were now being brought into prominence . . .

turning the Caribbean and Gulf plains into basins which became seas at the end of the [Pleistocene] elevation. The writer is inclined to regard broad submarine plateaux now at depths of 2500 to 5000 feet as terrace plains and terrestrial slopes like the coastal plains of the continent, representing the altitude of the Pliocene continent during a considerable portion of the period. . . . Thus the Atlantic waters were admitted to the region of the West Indies in the later part of the Pliocene period, to be drained off by terrestrial elevation in the early Pleistocene with perhaps a shallow connection with the Pacific in Mid-Pleistocene days, since which time there has been no connection with the Pacific, but free communication with the Atlantic."[1]

Alaska and British Columbia.[2]

The authors of the Correlation Papers, on the evidence there summarized, conclude that Alaska and British Columbia were above water during the Eocene to an extent as great as or greater than now. A submergence during Oligocene and Miocene succeeded, followed by a re-emergence during Pliocene to a higher level than now.

Spurr observes: "The Kenai series [Oligocene] shows that the rocks were formed entirely in fresh water. . . . In the period succeeding the post-Kenai revolution, the greater part of Alaska seems to have been land. . . . We have already seen how the comparatively level interior plateau with its ancient broad, shallow valleys, and mountains greatly reduced by erosion, points to the stability of the land for a long period subsequent to the Kenai revolution. . . . In the same manner the deep canyon-like valleys in which the present streams flow point to a decided and long-continued elevation of the land at the end of this period of stability. . . . We may believe that this elevation took place in late Miocene or early Pliocene times . . ." (*l.c.*, pp. 259, 262).

The Tertiary geology of Alaska and of northeastern Siberia is so imperfectly known that we must depend largely on the evidence from palæontology as to the former land connections between the two. The close resemblance between the Basal and Lower Eocene faunæ of Europe and North America is my chief warrant for assuming an extensive post-Cretacic connection mainly across the present Arctic ocean between Siberia and northwestern North America, and probably including the northern half of Bering Sea as far as the border of the continental shelf. The spread of the Camels into Asia, Africa and Eastern Europe in the Pliocene, and the many other faunal interchanges of that epoch, warrant the assumption of a Pliocene connection, and the repetition of these interchanges in the Pleistocene allows us to suppose that the connection was either continued or repeated early in that epoch. During the greater part of the Eocene the trend of evolution among the mammals in the two continents appears to have been a development of the autochthonic faunas; this may be taken to indicate, although it does not prove, a separation during this time. At the end of the Eocene and beginning of the Oligocene and again in the middle Miocene occur marked approximations in the faunal development of Europe and America. Many new types appear, which are much more closely related than were their predecessors. In some cases the genera are identical (*Titanotherium*, *Anthracotherium*, *Didelphys*, *Sciurus*, *Steneofiber*, *Cynodictis*, *Elotherium* in the White River Oligocene, *Dipoides*, *Amphicyon*, *Mustela*, *Potamotherium*, *Lutra*, *Trilophodon*, *Aphelops*, *Palæomeryx* in the Middle and Upper Miocene). Others are very closely related in the two continents. No identical genera are known to occur in the Middle and Upper Eocene of Europe and America. The few identifications that have been made of European fossils with American genera are based on very fragmentary materials and are certainly erroneous in some cases. These facts indicate a much closer connection between the continents after the Eocene, the mammals interchanging by way of Alaska and the circumpolar lands or pushing southwards from a common boreal center. For the purposes for which these maps were designed it is convenient to assume a continental connection at Alaska. The southern mountainous section of this region is the newest part of the territory and I have not included it in the connection, but have run the old coast line along the border of the continental shelf, through the middle of Bering Sea, cutting out the Aleutian peninsula and islands as a volcanic ridge of comparatively recent formation.

---

[1] Reconstruction of the Antillean Continent. Bull. Geol. Soc. Amer., Vol. VI, 1895, pp. 103-140.

[2] AUTHORITIES:—Clark, W. B. Correlation Papers, Eocene. U. S. Geol. Surv., Bull. No. 83, 1891. Dall and Harris, Correlation Papers, Neocene. U. S. Geol. Surv., Bull. 84, 1891. Spurr, Geol Yukon Gold Dist., Alaska. U. S. Geol. Surv., Ann. Reps., 1896-7.

Southern Hemisphere.

In regard to the southern hemisphere I have adopted in the main the views of Ortmann and Hatcher, especially as to the age of the Patagonian Tertiary horizons, and incidentally as to the probable age of much of the Australian and New Zealand Tertiary. These authors consider the marine Patagonian formation which underlies a large part of the Patagonian plains as Lower Miocene. The continental subsidence which must have partly preceded the laying down of this formation I have thought best to represent on the Oligocene map, and to represent on the Miocene map the subsequent elevation which enabled the æolian Santa Cruz formation (Middle or Upper Miocene) to be deposited up to and beyond the present shore outlines. A slight subsidence of the southern end of the continent in the Pliocene epoch is indicated by the Cape Fairweather beds, followed by a Pleistocene elevation, probably not very great, during which the fluviatile-æolian Pampean formation was laid down and the present topographic features mostly completed. The northward extension of the glaciers of Tierra del Fuego is regarded as occurring in Pliocene and Pleistocene; here, as in Australia and New Zealand, the exact epoch of glaciation appears to be still uncertain.

The most important point illustrated in the southern continental outlines, is the connection of South America and Australia with the Antarctic continent. This is generally regarded as having occurred at the end of the Cretaceous or the beginning of the Tertiary period. There appears to have been shallow-water archipelagic connection with New Zealand as well, probably via New Guinea, according to Hedley. There is no evidence to show that these connections were simultaneous, but it is convenient to represent them so on our map and to place them in the post-Cretaceous. During the entire Eocene, Patagonia continued to be elevated above its present level, various local fluviatile or æolian deposits representing different parts of this epoch, and Ortmann thinks that a shallow-water connection with Antarctica persisted into the early Tertiary.

The connection of Antarctica with Africa, at least during the time covered by this series of maps, is regarded by Ortmann as very doubtful, and it seems best to omit it here, as the series is intended to represent a somewhat conservative view.

For the former outlines of Australia and New Zealand, Hedley and Tate are my principal authorities, but some of their conclusions are modified in accordance with Ortmann's criticisms.

The proper correlation of the Tertiary deposits of the southern with those of the northern hemisphere is a difficult problem, and very discordant views have been expressed by different authors, especially as regards the Patagonian formations. Dr. Ameghino, to whose diligent and untiring researches is due most of our knowledge of the great Tertiary mammalian faunas of Patagonia, correlates the various horizons with considerable older epochs, and his views are accepted wholly or in part by Moreno, Mercerat, Roth, von Ihering and other South American geologists. But Mr. Hatcher's unequalled practical knowledge of the Mesozoic and Tertiary fossil fields of the interior of North America makes his views as to the stratigraphy of the corresponding formations of Patagonia, based on his explorations there in 1898–99, of peculiarly high authority, and Dr. Ortmann's correlation of the marine formations by their invertebrata is based on researches much more extensive and elaborate than any yet made. Recent observations on Patagonian stratigraphy by M. Tournouer seem to accord in the main with Hatcher's views. In accepting these stratigraphic views I am far from wishing to ignore or belittle the splendid palæontologic work of Dr. Ameghino, which when properly coördinated with the work of the great body of observers in the northern continents, will most certainly greatly extend our knowledge, and broaden our understanding, of the evolution of the Tertiary mammalia. The completion of the elaborate studies now being made by Professor Scott, with the assistance of Dr. Farr and Mr. Sinclair, of the fossil collections obtained by the Princeton and American Museum expeditions to Patagonia, will be a great step towards such coördination, and to the publication of their results we look forward with much interest.

For the remaining areas I have depended partly on de Lapparent and other writers already quoted, and very largely on Lydekker's 'Geographical Distribution of Mammals.' The evidence is in most cases derived chiefly from the modern faunas of the different regions, for little is known of their geology and almost nothing of their fossil mammals.

The supposed continent of Lemuria I have omitted except to indicate its possible pre-Tertiary existence in the string of islands connecting Madagascar with India. The various mid-Atlantic continents that have been suggested may likewise be relegated to pre-Tertiary time as there is no adequate evidence of their existence within the Cenozoic.

56.9, 725 A (1182: 79.5)

Article XXII.—A NEW GENUS OF HORSE FROM THE MASCALL BEDS, WITH NOTES ON A SMALL COLLECTION OF EQUINE TEETH IN THE UNIVERSITY OF CALIFORNIA.

By J. W. Gidley.

Archæohippus gen. nov.

Generic Characters.—Skull elongate as compared with *Mesohippus;* metaloph completely united with the ectoloph; protoconule distinct as in *Parahippus*, but the prefossette is open between the metaloph and protoloph, there being no crochet, or anterior median enamel fold in the wall of the metaloph; molars compared with premolars relatively large, their transverse diameters being more nearly equal to those of the premolars than in either *Parahippus* or *Hypohippus;* lachrymal and malar fossæ well developed, the latter forming a deep pit immediately in front of the orbit; anterior border of orbit above anterior half of m^3; lower p_1, as well as upper p^1, two-rooted [1]; both upper and lower molariform teeth with internal basal cingulum.

Archæohippus ultimus (*Cope*).

Type.—An anterior portion of skull (No. 8174 Am. Mus. Coll.) with nearly complete dentition, from the Mascall Beds, Cottonwood Creek, Oregon.

Paratypes.—A few teeth, belonging to the University of California collection, from the same beds and locality from which the type specimen came. These specimens comprise a last upper molar, m^3; a second upper premolar, p^2; a lower premolar, and a fragment of lower jaw containing parts of p_3 and p_4, and the roots and alveoli of p_1 and p_2. The numbers accompanying these teeth are respectively Nos. 1689, 1709, 1709*a*, and 1700.

These specimens, though very incomplete, supply some distinctive characters not shown in the type specimen, and I wish here to acknowledge my indebtedness to Dr. J. C. Merriam, of the University of California, for the privilege of examining and describing them.

The specimen taken as a type of this genus was fully described by Cope[2] under the name *Anchitherium ultimum*,[3] hence it only remains to point out the especial characters which distinguish it from other described genera. It is more advanced in several respects than any species of Oligocene horse and compares in degree of progression with the earlier species of *Hypohippus* and *Parahippus*.

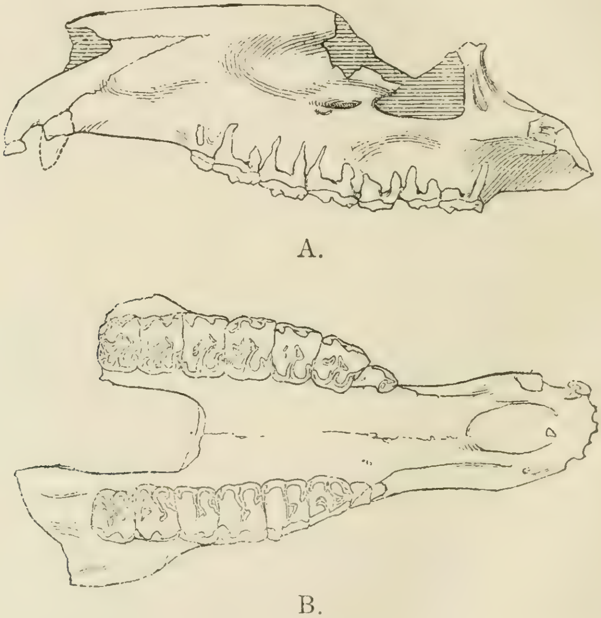
---

[1] Cope stated in his original description that the upper p^1 had but one root, but an examination of the type shows this to be an error. The greatest diameter of this tooth is 10 mm. instead of 7 mm. as given by Cope.

[2] Proc. Amer. Philos. Soc., Vol. XXIII, 1886, pp. 357, 358.

[3] Cope used this genus name not because of any supposed close affinities to the European genus ***Anchitherium***, but because all American species of the ***Mesohippus bardi*** type were at that time referred to ***Anchitherium***. Later writers placed *A.* ***ultimum*** with the others in Marsh's genus ***Mesohippus***.

From *Mesohippus* and *Miohippus* this genus is clearly distinguished by (1) the complete union of the metaloph with the ectoloph in the upper molariform teeth; (2) the proportionally larger size of the protoconule; (3) the greater lengthening of the anterior portion of the skull, as shown in the comparatively longer muzzle; (4) the more backward position of the orbit, and (5) the great development of the lachrymal and malar fossæ. It differs from *Parahippus* in (1) the absence or but slight development of a crochet on the metaloph; (2) the deeper notching of the external wall of the protoloph between the protocone and protoconule with a correspondingly less notching of the internal protoloph wall; (3) the comparatively more equal proportions of the molars to the premolars, and (4) the presence of a well developed internal basal cingulum. In the type, an old individual, the dentition is much worn by use and in some of the teeth the cingulum is nearly obliterated.



Archæohippus ultimus (Cope). No. 8174 Am. Mus. Coll. A, side view; B, palatal view.

Compared with *Hypohippus* (1) the protoconule is much larger than in that genus; (2) the molars in relation to the premolars are comparatively larger; (3) the muzzle is relatively longer; (4) the orbit is placed the width of a molar farther backward, and (5) the malar fossa, which is wanting in *Hypohippus*, is well developed, as is also the lachrymal fossa, with which it is nearly confluent, being separated only by a low rounded transverse ridge.

The lower teeth in the University of California collection show the additional characters of (1) a relatively strong two-rooted p_1, and (2) a well developed internal basal cingulum on the molariform teeth. The development of an internal basal cingulum in the lower teeth has not been observed in any other horse and is analogous to that seen in the *Palæotherium* of Europe.

This genus has advanced in development in many respects beyond any of the Oligocene horses and in its degree of progression ranks with *Hypohippus* and *Parahippus* while differing from both these genera. Thus in *Archæohippus* we have a third phylum of Miocene horses retaining brachyodont teeth, while more advanced in other respects than the Oligocene forms of the *Mesohippus* type. If, therefore, *Hypohippus* and *Parahippus* are to be retained as full genera, *Archæohippus* is likewise entitled to generic value.

Archæohippus sp.

In the California University collection from the Mascall beds there are two upper milk teeth (dp^1 and dp^2) and the anterior half of a third (dp^3), all apparently belonging to a single individual, which probably represents a second and larger species of *Archæohippus*. But since the specimen is so incomplete and moreover represents only the milk dentition, I prefer not to propose a new name and thus add to the already too long list of species founded on inadequate material.

These teeth are much too large to be referred to *Archæohippus ultimus*, but they show the characteristics of the genus. Dp^1 is relatively very large, the basal cingulum, especially along the anterior borders of the teeth, is well developed, there is a deep exterior notch between the protocone and protoconule, the protoconule is semi-crescentic and there is no spur or crochet on the metaloph. A peculiarity of these teeth is the regular continuity of the inner wall of the protoloph. The constriction between the protocone and protoconule is confined entirely to the outer or anterior wall, making the protoconule, which is greatly enlarged, assume a semi-crescentic form. This arrangement of the protoloph is, in a less pronounced degree, also characteristic of the type (milk) teeth of *Parahippus cognatus.* In *P. cognatus* the protoconule is more conic in outline and there is a slight infolding of the inner enamel wall of the protoloph.

In the development of the protoloph and especially in the relative proportions of the protocone and protoconule these teeth are intermediate in development between those of the *Mesohippus* and *Anchitherium* forms and the *Merychippus* and *Protohippus* type of molars. In *Mesohippus* the walls of the protoloph are infolded about equally, the protoconule compared with the protocone is very small and more or less conic in form. In the hypsodont forms of the *Merychippus* and *Protohippus* types the protoconule is larger than the protocone and entirely crescentic in form, having joined the metaloph by means of the fully developed crochet and antecrochet. In *Hypohippus* the protoconule is nearly or quite lost in the continuous protoloph. *Archæohippus*, in the more crescentic form of the protoconule, represents more nearly than does *Parahippus* a direct intermediate form between *Mesohippus* and the hypsodont forms, but in some other important respects it is less directly intermediate.

Two other specimens in the University of California collection remain to be mentioned, a single upper molar, m^1 or m^2, referrable to *Parahippus brevidens* (Marsh), and the anterior half of a lower milk tooth, referrable to some species of *Merychippus.*

All the teeth of this interesting little collection show characters of advanced development beyond any of the Oligocene forms, but are less specialized than the known Upper Miocene forms, thus tending to confirm the placing of the Mascall beds, from which these specimens were taken, in the Middle or Lower Middle Miocene.

56.2(1162:78.3)

Article XXIII.—REMARKS ON AND DESCRIPTIONS OF JURASSIC FOSSILS OF THE BLACK HILLS.

By R. P. Whitfield and E. O. Hovey.

Plates XLII—LXII.

The fossils described in this article are all from American Jurassic rocks, a geological horizon but little known in this country, and one that has received but little attention until within a comparatively short time. About 1855 Prof. Jules Marcou mentioned the occurrence of Jurassic rocks along the line of the Rocky Mountains, through the central portion of the United States. Previous writers had mentioned doubtfully the occurrence of Jurassic fossils at various places. In 1864 Messrs. Meek and Hayden published the first undoubted forms of this age in their 'Palæontology of the Upper Missouri,' in the Smithsonian Contributions, and later Mr. Meek figured several species of Jurassic age in Volume II of the Fortieth Parallel Survey. Still later, in Newton and Jenney's report on the 'Resources of the Black Hills of Dakota,' a still larger number of Jurassic forms are given. Up to this time very few collections of Jurassic forms were known. Field parties occasionally brought in from their explorations a few specimens that were referable to this group of rocks, and the American Museum of Natural History had received from such sources some twenty-five or thirty specimens, embracing perhaps a dozen species, illustrating this formation in its extensive collections.

In the spring of 1891, the Museum sent Dr. E. O. Hovey into the Black Hills of Dakota especially to collect from this group, this being thought to be the most favorable locality known; and the fossils figured and described in this paper are the direct results of that expedition.

Pentacrinus astericus M. & H.

Plate XLII, Figs. 1–3.

Among the Crinoidal remains brought with the Black Hills fossils are several specimens of *Pentacrinus asteriscus* Meek & Hayden that show rather more of this organism than any hitherto obtained. On Plate XLII there are given three figures, by photography, of some of these specimens. Figure 1 of the plate is of natural size, and shows a fragment of column, badly weathered and worn, retaining at the top some of the calyx plates and bases of three of the arms, and along the sides of the stem are shown parts of the fimbria usually present on the columns of this genus of Crinoids; while the rock in which it is preserved is largely composed of the broken up remains of this species.

Figure 2 of the same plate, enlarged to two diameters, shows another specimen which preserves the column with the fimbria and one side of the calyx and bases of three of the arms to the first bifurcating plate, or to the third radial, of each of three arms to this point. The subradials, alternating with the first radials, are minute, but appear as bulbous protuberances at the top of the column between the first radials. The column is small and pentangular in the upper part, with the fimbriations at irregular distances, but near the head the sides of the column show punctations at the junction of each disc, as if for attachment of fimbria.

Figure 3 is also enlarged to two diameters, and was photographed sideways, thinking to bring into better relief the lower plates of the body. The base of the calyx is gone, but the cuneiform plates of three rays are seen and parts of the arms of these rays, but beyond the arm plates all the parts are so obscured and indistinct that but little can be said about them. The arms appear to have been rounded on the back, and show no particular sculpturing. The fimbria of the column are also round and are composed of rather short joints. The column discs as found on the surface of the rocks are very variable, some showing a simple pentagon, while others are sharply stellate with deeply reëntering angles, and with all grades of form between. Meek's figure given on Plate III of Palæont. of the Upper Missouri gives a very fair general expression of their appearance, although the stems, seen imbedded in the rock, are mostly plainly pentagonal with flat sides. The woodcut on p. 67 of the same work also shows well the general features of most of the specimens observed.

Mr. Meek seems to have had doubts as to whether this species from the Black Hills was really distinct from *P. scalaris* of Goldfuss. We have in our collection fine specimens of *P. briarius* and *P. subangularis* with stem attached. We have also stems and stem discs of *P. bavaricus* Winkler; *P. cingulatus* Munster; *P. scalaris*, and *P. pentagonalis* Goldfuss, but it would be very difficult or impossible to confound this American species with any of these without too great a stretch of probability.

Meek's specimens are said to have come from Red Buttes and North Platte River, southwest base of the Black Hills. The specimens in the Museum collection are from near Elkhorn, S. D., and from Redwater Creek, near Sundance, Black Hills Jurassic formation.

Ophiocten (?) **bellefourchensis** n. sp.

Plate XLII, Fig. 4.

Several specimens of an Ophiurian occur in the collection of Jurassic fossils from the Black Hills. They are imbedded in a sandy limestone and are extremely imperfect and unmanageable, and are referred with much doubt to any established genus.

The body is discoid, that of the largest individual being thirteen mm. in diameter. It seems to be composed of minute plates, apparently squamose in structure and arrangement, although from the fact that all are imbedded disc down, the arrangement is impossible to determine satisfactorily. The arms at their insertion on the underside of the disc on each side are bordered by a single large lateral plate (lateral shield of authors), and at the base of the arm the usual forked or Y-shaped plate, composed of two or possibly three elements, is seen, and between the posterior arms, or opposite the anterior arm, occurs a rather large oval madreporite. The arms on the ventral surface are composed of a central narrow groove, when not worn, with marginal plates which are spine bearing. These lateral plates appear to be composed of several elements, the number and form not being determinable. The arms have been proportionally long, rather robust in their median portion, but more slender near the disc and at their origin. The anterior arm, or that opposite the madreporite, in the larger individual, has been fully four centimeters long, measuring from the central opening.

Locality.—These specimens are all from a sandy limestone occurring in Belle Fourche Valley, Wyo. Collected by Dr. E. O. Hovey.

The species is an attractive form, but all four of the specimens are so weather-worn that it is difficult to obtain from them enough positive features to characterize the species. There is but slight chance of its generic characters being identical with those of *Ophiocten;* we therefore propose for it the provisional name **Ophioaster**.

Cidaris bellefourchensis n. sp.

Plate XLII, Fig. 5.

There are two distinct forms of Cidaroid spines associated in the same locality with the *Ophiocten* and *Pentacrinus* stems, but which are probably only those of a single species of Echinoderm. One of these is figured on Plate XLII, Fig. 5, and is probably a primary spine. The shaft is cylindrical and longitudinally ridged and when entire was about 5 cm. in length. The head of the spine below the collar rapidly tapers to the articulation, which is perforated, and the collar has apparently been crenulated. The shaft is contracted above the head and then gradually swells to about one third of its present length, which would be one fourth of its original length, above which point it gently tapers throughout its length. The shaft is marked by about fifteen raised granulated ridges on which the granules or tubercules are closely arranged. The second specimen is much smaller, but presents similar features, only reduced in strength corresponding to its dimensions. A third spine occurs in the collection, but it is small and very finely but deeply striated longitudinally, and most likely belonged to a distinct Echinoderm.

Locality.—In sandy limestone, Belle Fourche Valley, Black Hills, Wyo. Collected by E. O. Hovey.

Pinna jurassica n. sp.

PLATE XLIV and PLATE XLV, Fig. 1.

Shell of medium size, elongate triangular, very gradually and regularly widening throughout its length, the dorsal and basal margins being quite straight. The largest specimen of the species is a trifle over five inches in length by one and three fourths inches at the outer end in its flattened condition. The species belongs to the group of true *Pinnæ*, those having a median sulcus, and not to the *Atrina* group. In this particular species the median sulcus is quite a prominent feature, and by it each valve is sharply divided into two sections. This median sulcus would appear, from the specimens, which are largely in the shape of internal casts, to have been closed at the beak end, and for some distance beyond (quite variable in different individuals), then to have been open to the posterior end, as if the shell had been absolutely divided into four parts instead of into only two valves. So strongly is this the case that the fracturing of the limestone is very distinctly shown between the two sections of the valve through the median sulcus.

Cardinal division of the shell distinctly marked by from seven to nine longitudinal ridges which become rather faint on the larger part of the shell, and on the lower side by three or four ridges, situated below the sulcus, also by concentric furrows indicating the outline of the valve, which are prolonged at the cardinal margin and broadly rounded backwards below.

There is no species of *Pinna* that can be readily confounded with this one, as the strongly marked median sulcus will easily distinguish it. The species seemed to have been exceedingly abundant, as the particular layer of limestone in which it occurs is quite well filled with the shells, as may be seen in the group figured on Plate XLIV.

Locality. — Red Cañon, S. D., Black Hills. E. O. Hovey, collector. In October, 1897, Dr. Wortman, at that time of the Museum, brought specimens of this species from Freezeout, Albany Co., Wyo.

Modiola jurassica n. sp.

PLATE XLV, FIGS. 3 and 4.

Shell above medium size for the genus, very transverse, but decidedly modioloid in character. Beaks small, enrolled, and situated back a little distance from the anterior end, slightly angular on the umbo, the angulation continuing backwards forming a prominent ridge along the umbonal region for nearly one third of the length of the shell, where it becomes rounded and lost in the general prominence of the valve. A distinct oblique sulcus crosses the valves from the beaks to the basal margin just in front of the umbonal prominence. Hinge line straight, highest behind; from which point the posterior end is obliquely rounded and prolonged below the middle. Basal margin broadly emarginate just behind the middle by the mesial sulcus which crosses the valves. Anterior end full and prominent. Surface marked only by concentric lines of growth.

Somewhat resembles *Modiola (Volsella) formosa* M. & H., figured and described in Palæont. Up. Missouri, pages 86 and 87, figures A and B, but differs in the length of the hinge line, in the greater length and prominence of the anterior end, and in being destitute of surface striæ.

Locality. — Lookout Peak, Spearfish, Black Hills, S. D. Collected by E. O. Hovey.

Modiolarca jurassica n. sp.

PLATE XLV, FIG. 2.

Shell very small, measuring 13 mm. in extreme length, very ventricose, modioliform, much higher behind than in front. Beaks situated almost anterior, proportionally large, inflated, but distinctly sulcated by an oblique sulcus which crosses the valve to the basal margin which it decidedly modifies. Surface marked by concentric undulations only, which are strongest behind the very prominent umbonal ridge.

Locality. — Belle Fourche Valley, 1½ miles northeast of Devil's Tower, Black Hills, in white limestone of the Jurassic formation. Collected by E. O. Hovey.

Septifera sturgisensis n. sp.

Shell small, decidedly mytiliform, very acute and a little more than twice as long as the greatest width. Beak sharp, byssal side straight or only slightly concave for nearly its entire length. Hinge line quite short, less than the width of the shell below; base sharply rounded; posterior margin broadly curved giving to the form of the valve a greater width at the lower fourth than above. Buccal area below the beak swollen on the anterior side. Surface of the shell sharply ridged along the center from the beak to quite near the base. Surface concentrically marked with strong undulating lines of growth. Only right valves are known.

On breaking the rock under the beak the internal plate or septum was seen to extend about one twelfth of an inch from the beak on a specimen 23 mm. long from beak to base.

This shell quite closely resembles *Mytilus whitei* Whitfield, described in Newton and Jenney's Report of the Resources of the Black Hills of Dakota, p. 360, plate v, figs. 9–12, but the hinge line is so much shorter, and the shell so greatly narrowed above, that it can hardly be mistaken.

Locality.—Found 2½ miles northwest of Sturgis, S. D., and at Redwater Creek, Sundance. Collected by E. O. Hovey.

Astarte dacotensis n. sp.

PLATE XLV, FIG. 5–7, and PLATE XLVI.

Shell small, circular, ventricose, nearly equilateral. Beak only slightly prominent, not protruding, directed slightly forward. Lunule distinct and well marked; escutcheon also quite distinct but narrow. Surface of the shell marked by strong, rather deep, simple concentric furrows and ridges parallel to the outer border of the shell, those near the beak being more closely arranged and gradually becoming more distant toward the border. On a full grown shell measuring 2 cm. in height from beak to base the ridges count eight in the space of 1 cm. near the middle of the height. Other and finer concentric lines are seen marking the surface when examined under a magnifier.

On internal casts the adductor muscular scars are seen to be rather large and prominent, situated considerably above the middle of the valve. The outline of the shells of the species varies but little in different individuals, and the ventricosity of the valves is rather uniform.

Localities.—Specimens have been found at Spring Creek, Pennington Co., S. D., at Red Cañon, and several other localities. The species also occurs, but without locality mark, among Jurassic fossils in the Cope collection, and specimens were also brought in from Freezeout, Albany Co., Wyo., by Dr. Wortman's party. The fine block figured on Plate XLVI is from Red Cañon, S. D., and was collected by E. O. Hovey.

Trigonia sturgisensis n. sp.

PLATE XLVII and PLATE XLVIII, FIGS. 1–3 and 7.

There are two distinct forms of *Trigonia* in the Black Hills material, both of which seem to be undescribed. One of these, the one placed under the above heading, occurs at three different localities, and each in a different matrix, which gives them a somewhat different appearance one from the other. Still I am inclined to consider them as belonging to the one species.

The one form, that from 2½ miles northwest of Sturgis, S. D., as represented on Plate XLVII and on Plate XLVIII, Fig. 7, consists entirely of internal casts, and is preserved in a soft sandy rock, much weathered and consequently shows but faintly any of the actual surface markings. They are generally of a decidedly ovate outline, largest anteriorly, measuring about 6 x 4.5 cm. and rather more than moderately convex, while on some of them there remains a fairly well defined umbonal ridge, extending from the beaks backward to the posterior angle, with moderately well defined concentric markings on most of them. Besides this, there are a number of strong, moderately distant, short plicæ crossing the disc of the valve from the position of the umbonal angle, obliquely backwards, across a rather faintly marked sulcus, just below the unbonal ridge and uniting with the concentric undulations where meeting them, forming thereby a system of acute V-shaped angles, which thus mark the body of the valves. These V-shaped figures have extended up to, and onto the beaks, each one becoming shorter than the one below. The posterior slope, above the umbonal ridge, seems to have been marked only by concentric undulations.

The second form, that from the second locality, which is Belle Fourche Valley, 2 miles northeast of Mato Teepee, or Devil's Tower, Wyo., is much smaller than the above, seldom exceeding that of Fig. 3, of Plate XLVIII. They are similar in form and surface markings, and on them the V-shaped sculpturing is quite strongly shown on the umbo, as well as near the posterior basal angle, and along the basal margin of the valves the concentric undulations are distinct. On the specimen shown in Fig. 3, just mentioned, there are some faint indications of fine radiating striæ traversing the cardinal slope. But these are quite problematical.

Those from the third locality, which is Belle Fourche Valley, 3 miles north of Hulet, Wyo., and 75 feet above the base of the Jurassic, or about 50 feet above the bed in which the second form occurs, are also in an entirely different kind of deposit. Still in size and all specific features, these two are alike, scarcely differing from the Sturgis specimen except in size and strength of surface markings.

Considering these circumstances and that the three localities differ but little in the elevation of the strata in which they occur above the base of the Jurassic bed in the Black Hills it is considered unwise to separate the three forms specifically.

All the examples were collected by E. O. Hovey.

Trigonia poststriata n. sp.

PLATE XLVIII, FIGS. 4-6.

Shell much below medium size for the genus, depressed convex, decidedly angular along the umbonal ridge, almost sharply so, posterior cardinal slope slightly concave, while the disc of the valves is gently and evenly convex from beak to the basal border, and from the umbonal ridge to the anterior end of the shell. General form of the outline of the shell quadrate, with the anterior end rounded. Hinge line about one half the length of the shell, posterior end obliquely turncate, longest at the postero-basal angle, where the sharply angular posterior ridge strikes the basal and posterior margins. Basal line gently and evenly curved. Beaks small, pointed, situated rather behind the anterior third of the shell's length.

Besides the fine striæ of the postero-cardinal slope, the anterior end of the valves is marked by what might be called pseudo-concentric lines, lines that are not concentric but which are connected and coincident with the concentric undulations of the surface, but which are deflected from the concentric lines and pass off downward and outward to the anterior margin, instead of to the cardinal margin. These lines are somewhat coarser than the true concentric undulations, and extend over about the anterior third of the valves.

The surface sculpturing of this shell is peculiar and will serve to distinguish it from all other known species of the genus.

Locality. — In sandy shales of Jurassic age, in the Belle Fourche Valley, 4 miles southwest of Hulet, Wyo. Collected by E. O. Hovey.

Tancredia transversa n. sp.

PLATE XLIX, FIGS. 1 and 2.

Shell of medium size or larger, very transverse, narrowly elliptical. Beak subcentral, or a very little anterior to the center, apparently pointed backwards from the deeper excavation just posterior to its position, but really directed toward the anterior end. Shell smooth except for faint concentric lines parallel to the margin of the shell. Shell substance quite thick and usually crystalline when preserved in a limestone matrix.

Resembles *Tancredia inornata* Meek—*Astarte inornata* M. & H., Pal. Up. Missouri, p. 94, pl. iii, fig. 12. See also, Pal. Black Hills, Whitf., pl. vi, figs. 9-13, of which the specimen represented by fig. 11 is probably not correctly identified, and should very possibly be referred to the present form, which is much more transverse and narrower than *T. inornata*, with the beaks less prominent and more nearly central.

Locality. — Occurs in a limestone matrix with *Comptonectes bellistriata* M. &. H. and *Ostrea strigillecula*, 2½ miles southwest from Sturgis, S. D.

Quenstedtia planulata n. sp.

PLATE XLVIII, FIG. 11.

Shell depressed convex, transversely ovate, tellinaform. Beaks small appressed, projecting but little above the line of the hinge and situated slightly in front of the middle of the length of the shell. From the beak the anterior cardinal margin of the shell is broadly rounded to the anterior end, thence more narrowly rounded to the base, which is gently curved and arched to the posterior umbonal angle, above which the posterior margin is rather narrow and obliquely receding to the posterior hinge line. The posterior hinge line gently declines and is straight from the beaks to the end of the shell, and the edge of the shell is abruptly inflected, forming a narrow escutcheon for the entire length of the hinge behind the beak. The umbonal angle from the beak to the posterior basal angle is at first sharply defined, becoming less distinct toward the end of the shell. Body of the shell marked by distinct irregular concentric lines of growth, and the posterior cardinal slope is gently concave.

There is no American shell below the Tertiary that can well be confounded with this one. It is decidedly Psammobia-like in its general aspect. The figured specimen is in a light-colored Jurassic sandstone from north of Crow Peak, S. D. A second one, more poorly preserved, is from Belle Fourche Valley, 4 miles southwest of Hulet, Wyo. Collected by E. O. Hovey.

Pleuromya ? concentrica n. sp.

PLATE XLVIII, FIGS. 8 and 9.

Shell of medium size, oval or ovate in outline, moderately convex. Beaks rather large, somewhat prominent, situated rather more than a third of the length from the anterior end. Anterior end pointed or sharply rounded, longest below the middle; posterior end more broadly rounded, longest above the middle. Basal margin strongly arched. Surface of valves marked by strong concentric undulations, parallel to the margin of the shell, of which about five will occupy the space of half an inch on the center of the valve below the middle of its height. The shell, much of which is preserved on the best specimen, has been very thin and the surface apparently smooth, except for the concentric undulations.

The second specimen, which is entirely an internal cast and somewhat vertically compressed, shows strong anterior muscular scars, but all other internal features are very obscure.

Localities. — The first mentioned specimen is labelled Red Cañon, southern Black Hills. The last one is labelled "Opposite mouth of

Inyan Kara Creek, Wyo. Loomis Coll."; the other stands credited to E. O. Hovey.

Pholadomya obscura n. sp.

PLATE XLVIII, FIG. 10.

Shell below the usual size for this genus, very transversely elongate, being fully twice as long antero-posteriorly as the height from base to hinge line, exclusive of the projecting beaks. Beaks large, protuberant, extending much above the general line of the hinge, situated near the anterior end, which is slightly truncate and receding below; basal line strongly curved, protuberant in the middle of the length, posterior end truncate, narrow, receding above to the extremity of the hinge line. Surface strongly grooved concentrically, or undulate. On the opposite side from that shown in the figure, the postero-cardinal portion of the shell shows a few (three or four) slightly defined, radiating ridges, which are not visible on the side figured, but which are distinct enough to characterize the specimen as a poor representative of the genus *Pholadomya*.

Locality. — In light colored sandy rock of the Jurassic, at Redwater Creek Valley, north of Crow Peak, S. D., 25 feet above the red beds accounted as Triassic. Collected by E. O. Hovey.

Teredo ? sp.

PLATE XLIX, FIG. 3.

Among the material brought in from the Jurassic formation of the Black Hills are some specimens containing burrowings of a mollusk, but none of them appear to contain remains of the shells which excavated them. They resemble burrows of *Teredo* more nearly than those of any other genus of burrowers such as *Saxicava*, *Pholas*, or *Lithodomus*, as they are more tortuous in their direction than would be the case in any of those, and the form of the terminal bulb shows more similarity to those of *Teredo* than of any other. They are in limestone, and some show remains of molluscan shells among their fillings, but these are mostly fragments of oysters. Many of the burrows are filled with muddy sediments only. The rock in which they occur may have been a loose mass, but the surface shown by the photograph is a fresh fracture, while the opposite side may have been part of an oyster bed, judging from the occurrence of shells of that kind on it. There is nothing about them that would indicate the kind of animal which made them or to suggest an appropriate name for their designation.

Locality. — They are from the Divide between North and South Forks of Redwater Creek, one half mile east of Sundance, at the top of the Belemnite shale, Wyo. Collected by E. O. Hovey.

Neritoma (?) (Oncochilus) occidentalis n. sp.

PLATE L, FIGS. 1–6.

Shell neritaform, smooth except for rugose concentric lines of growth which sometimes appear almost like distinct varices. Spire consisting of from two to about three volutions, of which the last one forms almost the entire bulk. Aperture large, very transverse, the margin thick and continuous from the base of the columella to its junction with the body of the preceding volution, axis imperforate, the columellar lip forming a broad flattened plate like that of *Nerita*, the margin of which is smooth or undulated (?) like that of *Velates*.

Surface of the shell quite commonly marked by revolving color bands, generally in black and white, but which do not appear to be at all uniform in width or position. Sometimes the last volution is all white, others may be mostly black with white encircling streaks.

The shell is very like *Nerita peleronta* in its general form and in the obliquity of the aperture, but some of them are much more conical, and the spire somewhat pointed. The margin of the inner lip is rather obscure, but on the largest one figured, the margin would appear to be undulated on the edge.

Locality. — In a white limestone of Jurassic age, on the east side of Sundance River, between the forks of the Redwater, Wyo. Collected by E. O. Hovey.

Belemnites obtusus n. sp.

PLATE L, FIG. 9,

Among the many specimens of *Belemnites densus* M. & H. in the collection from the Black Hills Jurassic, there occurs a single one which differs so materially in form from *B. densus* that it has been deemed safer to consider it as a distinct species than to refer it to that one.

The specimen differs from those of *B. densus* in being thickened below instead of slender and pointed; the greatest diameter is one and one fourth inches from the lower end, and the extremity is bluntly rounded instead of pointed. It is again slightly contracted above. In all other respects it resembles *B. densus* Meek & Hayden.

The specimen does not appear to be the result of accident, or to be dependent on abnormal growth or thickening. When broken open it appears entirely normal except that the phragmocone does not show the usual septate character as do those of *B. densus*. See Plate L, Figs. 7 and 8.

Locality. — North side of Redwater Valley, north of Beulah, Wyo. Collected by E. O. Hovey.

Ammonites (Œgoceras) subtumidum n. sp.

PLATE LX, FIGS. 3–5; PLATE LXI, FIGS. 1 and 2.

Shell attaining more than medium size, and extremely variable in different individuals, and at different stages of growth. Section decidedly cordiform when not compressed, the volutions imbedded about one third of their diameter, giving a moderately large umbilicus which in the larger (older) specimens has vertical sides. At the period represented by the individual figured on Plate LX, Figs. 3 and 4 (two views of the same individual), the shell is generally very strongly annulated, or marked by very strong transverse and deeply marked ridges crossing the volution, beginning at the edge of the umbilicus as a single protuberant transverse node or ridge, dividing midway of the side into two or three sharply elevated ridges, having a strongly forward curvature in crossing the dorsum, with an additional intercalated ridge added to fill up the space after crossing the outer half of the shell.

Another specimen, no larger than this, increases in lateral expansion nearly twice as rapidly as the one figured. The transverse ridges are much more numerous, counting nine or ten in the space occupied by eight on the figured one, and fully four at the edge of the umbilicus in the space of three on the figured one. The greater lateral expansion also gives to the shell a much more rapidly expanding form. Now if we consider the specimen figured on Plate LXI, it will be seen that at the margin of the umbilicus, these transverse ridges form strong distant nodes, differing much from those of the first mentioned specimen and in crossing the dorsum they are fewer in number but much stronger, still retaining the forward curvature in the dorsum. In this specimen it will be seen that nearly the outer half of the volution represents the chamber of habitation and that no septa are present, while the surface of the specimen is almost smooth, only faint undulations being preserved and only seen when the light is directed across them. Besides this the section of the volution is proportionally contracted in a dorso-ventral direction, and the shell has lost the nodes along the border of the umbilicus. Some of these differences may be due partly to a dwarfing of growth, but only to a very slight extent. On another specimen of about the size of the figure given on Plate LXI, which is septate throughout, the nodes on the margin of the umbilicus are retained to a much later growth and the section of the volution is strongly cordiform. The height of the section from the umbilicus is 8 cm. and the transverse diameter uncompressed equals 10 cm.

The sutures in this species are extremely complicated as well as very variable. In some specimens they are distant, with considerable space between them. In others they are crowded together and interlocked to so great an extent that it is next to impossible to trace their parts. The divisions or extremities of the saddles are usually rounded or lobate, while the parts of the lobes are sharp and pointed, with many ramifications. A photographic figure of the back of one of the closely compacted sutured specimens is given, natural size, on Plate LX, Fig. 5. And on a fragment of what appears to be a portion of a large individual of probably the same species, lately received from Baja Banda, Lower California, on which the sutures, measuring from the lower extremity of one suture to the same point of the next one forward or behind on the line of the dorsum, measure 83 mm. or about 3¼ inches, there is hardly a space an eighth of an inch wide that is not intersected by the interlocking of the ramifications of the adjoining sutures anywhere seen on the side of the specimen.

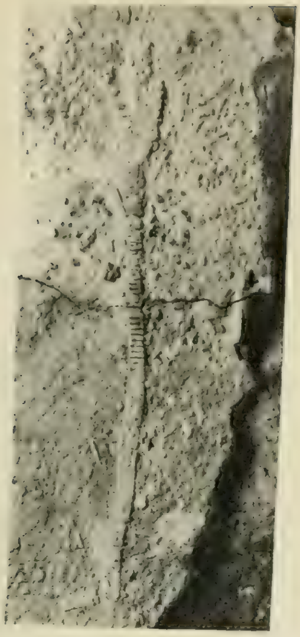
Localities. — The specimens from the Black Hills referred to this species are from Red Cañon, Southern Black Hills, a half mile south of Mathias Peak, collected by E. O. Hovey; and from the Belle Fourche, opposite the mouth of Inyan Kara Creek, Wyo., presented by F. B. Loomis. The fragment of the large specimen mentioned as from Baja Banda, Lower California, was presented by C. R. Orcutt of San Diego, Cal., and may possibly represent a different species.

NOTES ON CHANGES OBSERVED IN *Ammonites* (*Amaltheus*) *cordiformis* M. AND H. DURING LATER STAGES OF GROWTH.

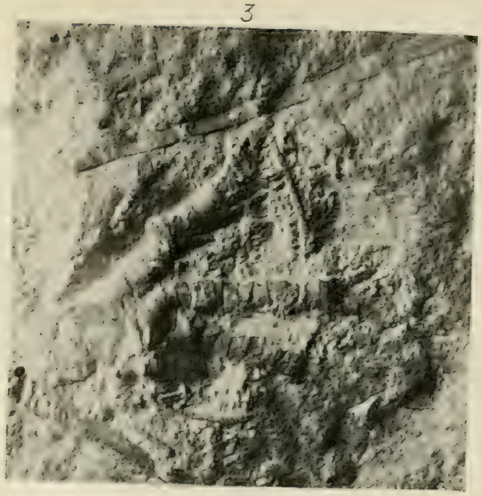
In an article published in this Bulletin (Vol. XXII, Article VII, pp. 131–134) some remarks were made about the changes which had been noticed to take place among *Ammonites* in their passage through the different stages of development towards the adult or final stages of growth. It was there stated that in the case of *Am. cordiformis* M. & H. from the region of the Black Hills of South Dakota many such changes had been observed.

In the earlier stages of this species all are of similar character, but in those of more advanced ages many changes occur. And the plates representing that species preserved in the Museum collections are here arranged to show some of the peculiar features undergone by that form in its progress to old age. The figures given on Plates LII and LIII show the usual form of the species as known to Messrs. Meek and Hayden, from the Black Hills region, while on Plate LIV, and on Plate LIII, the right hand figure, shows one of the extreme forms produced in the species in what may be adult age of certain individuals. The remaining plates portray what may be the normal form of the species, where the body of the shell is expanded laterally so as to present a broad ventricose form instead of the thin flattened shell shown on Plate LIV. This specimen is broken so as to show that the next inner volution is as strongly corrugated as that shown on Plate LII.

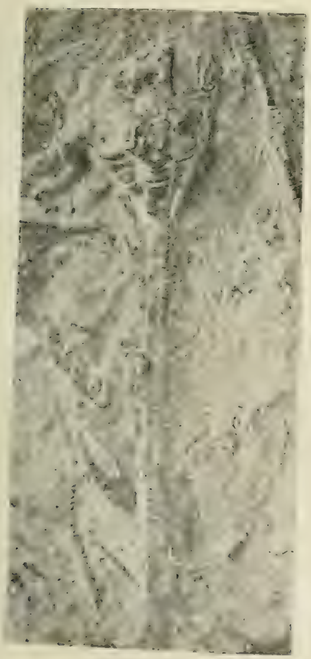
1



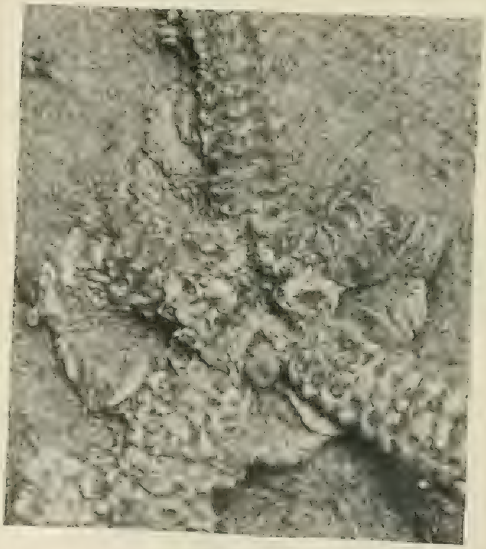
3



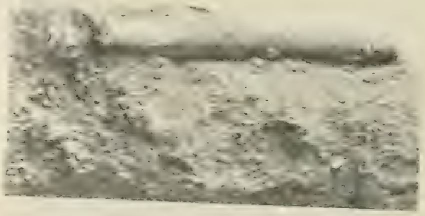
2



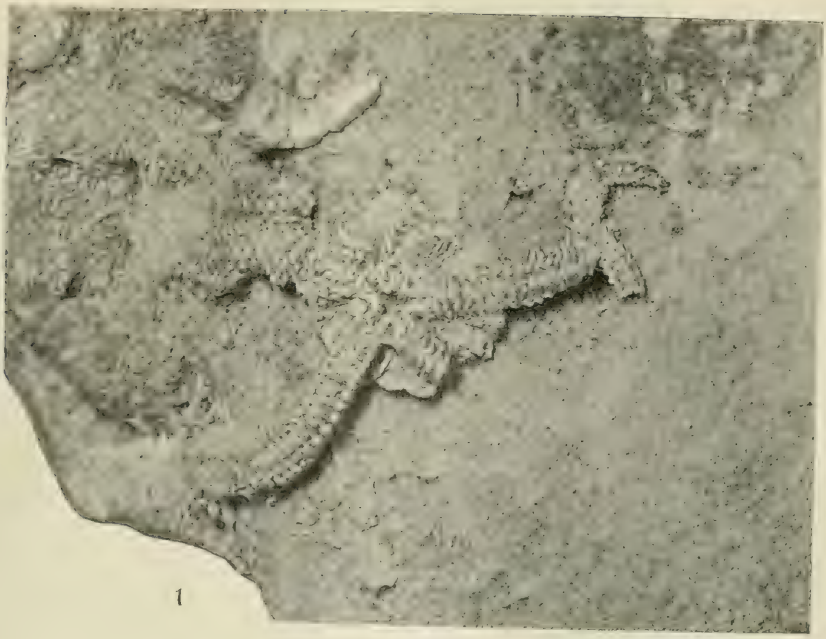
4



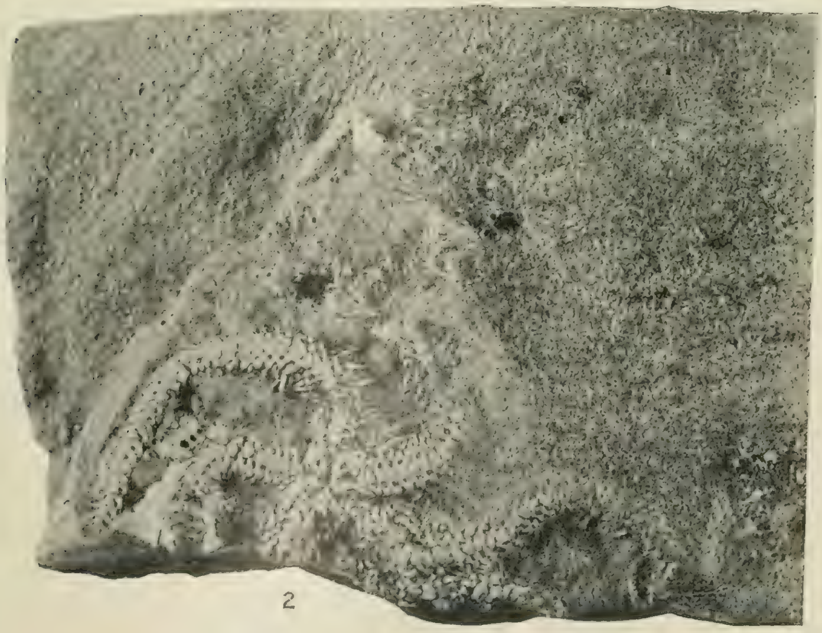
5



BLACK HILLS JURASSIC FOSSILS.

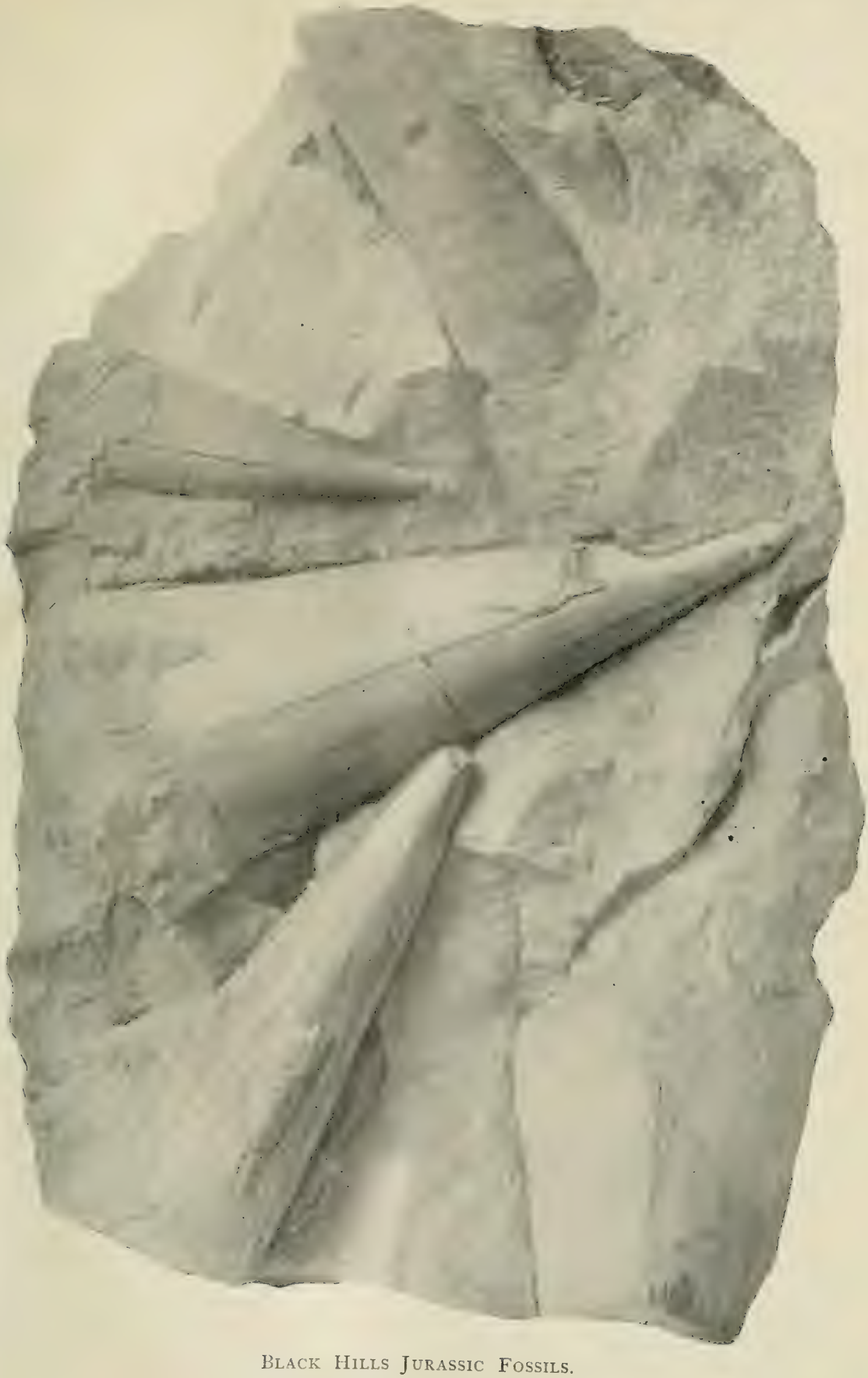


1



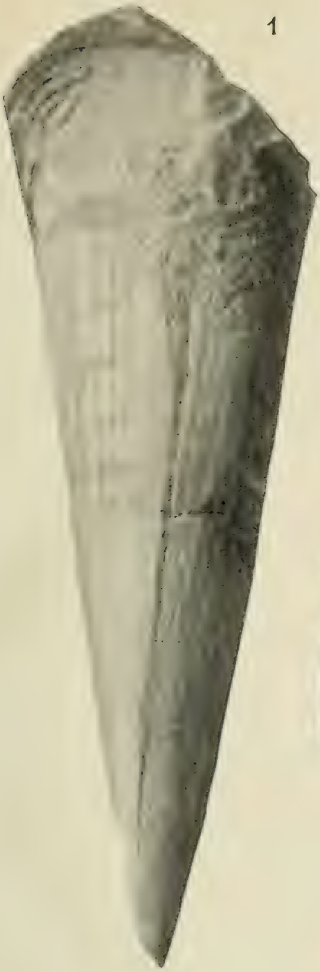
2

BLACK HILLS JURASSIC FOSSILS.

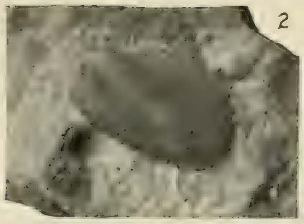


Black Hills Jurassic Fossils.

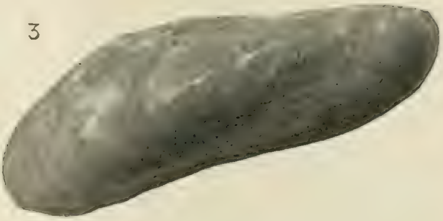
1



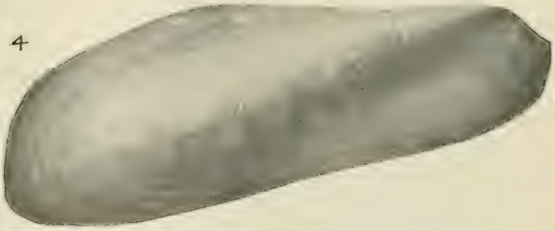
2



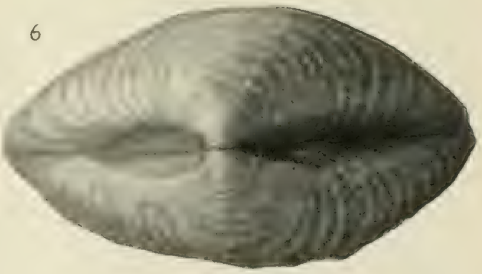
3



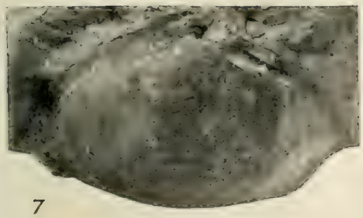
4



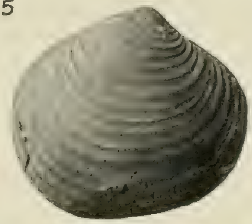
6



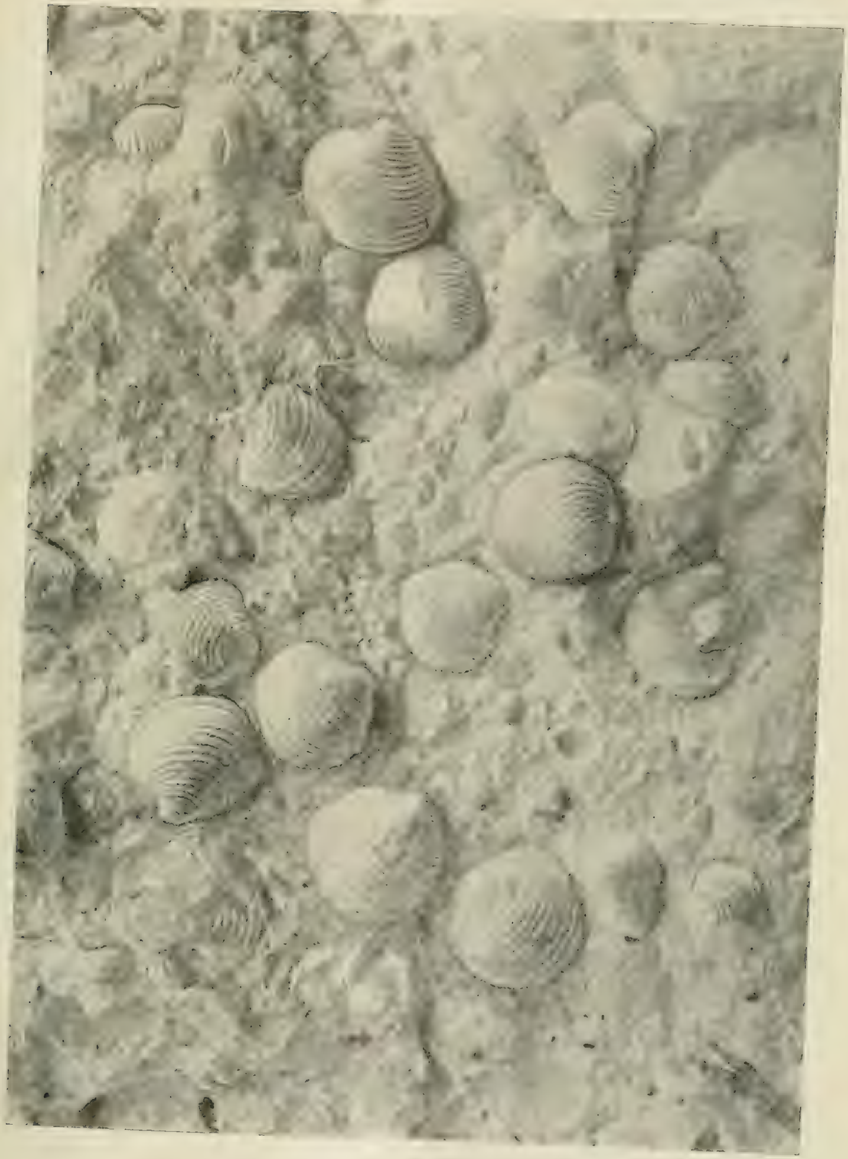
7



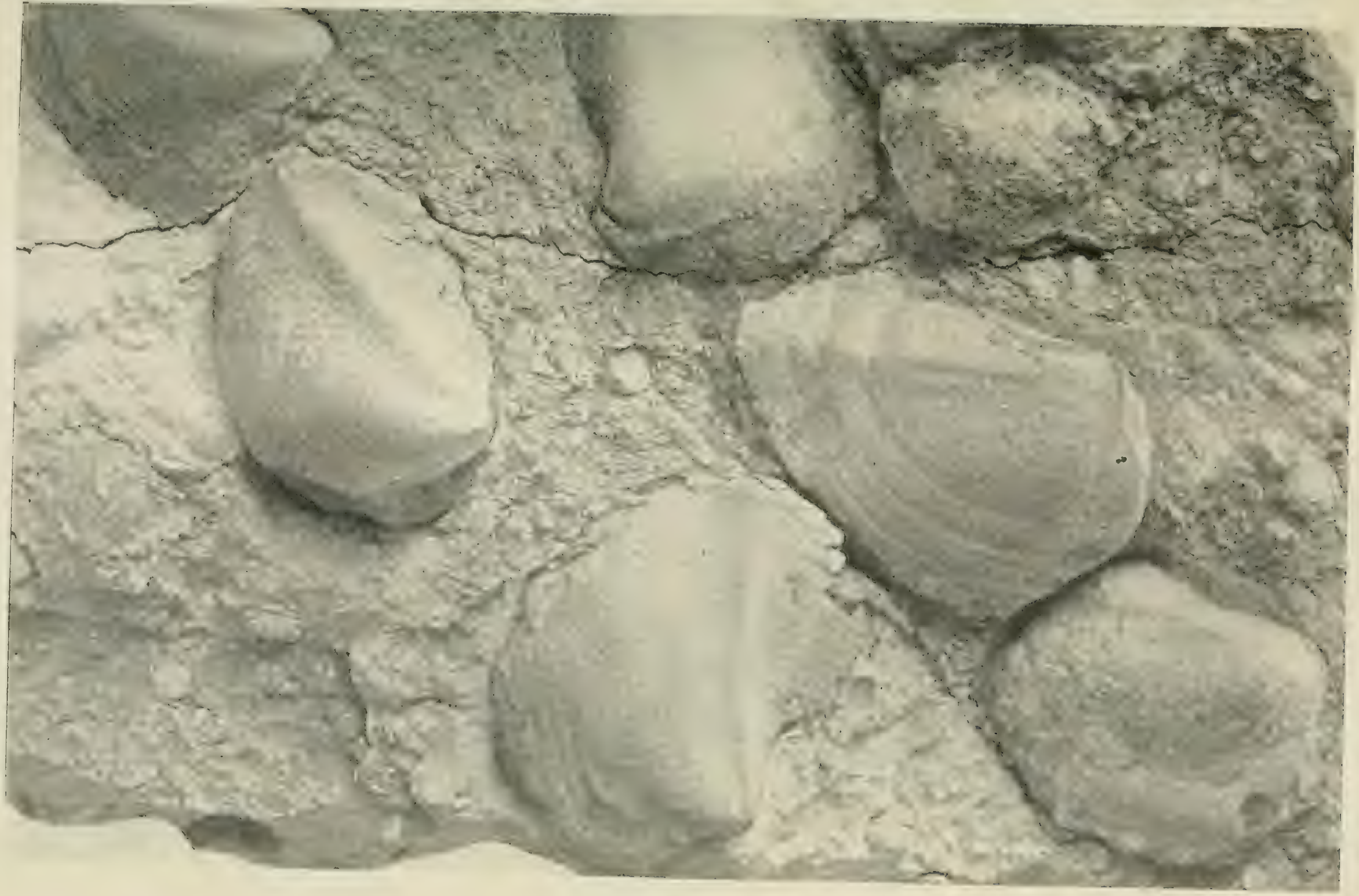
5



BLACK HILLS JURASSIC FOSSILS.

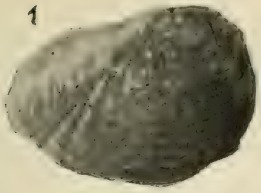


BLACK HILLS JURASSIC FOSSILS.

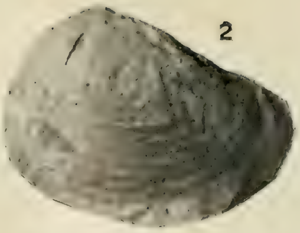


BLACK HILLS JURASSIC FOSSILS.

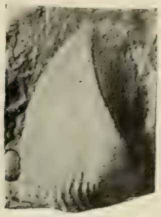
1



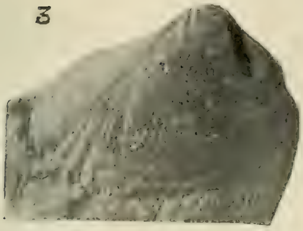
2



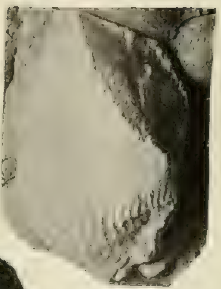
4



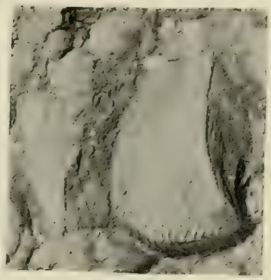
3



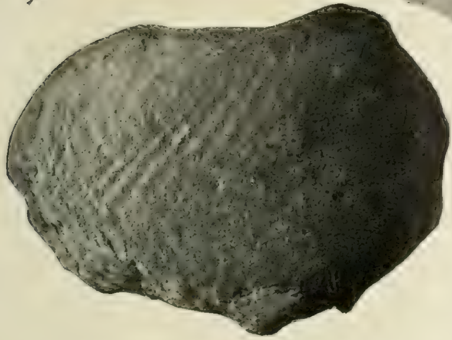
6



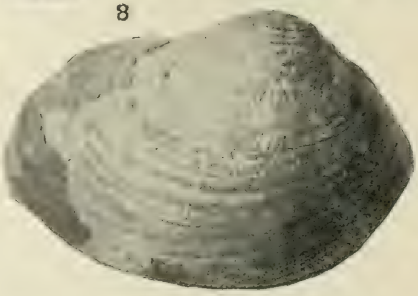
5



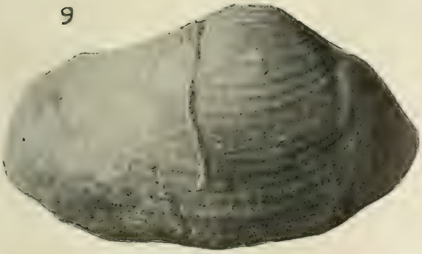
7



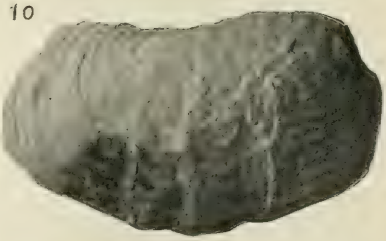
8



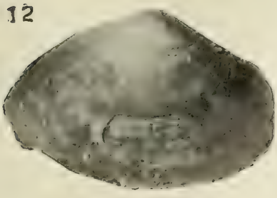
9



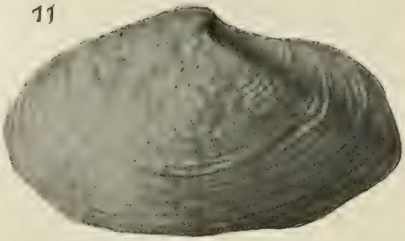
10



12

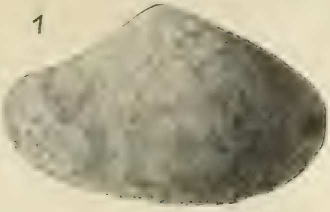


11

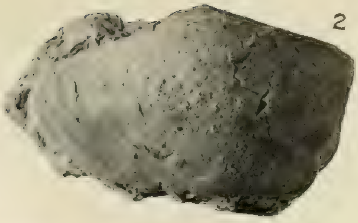


Black Hills Jurassic Fossils.

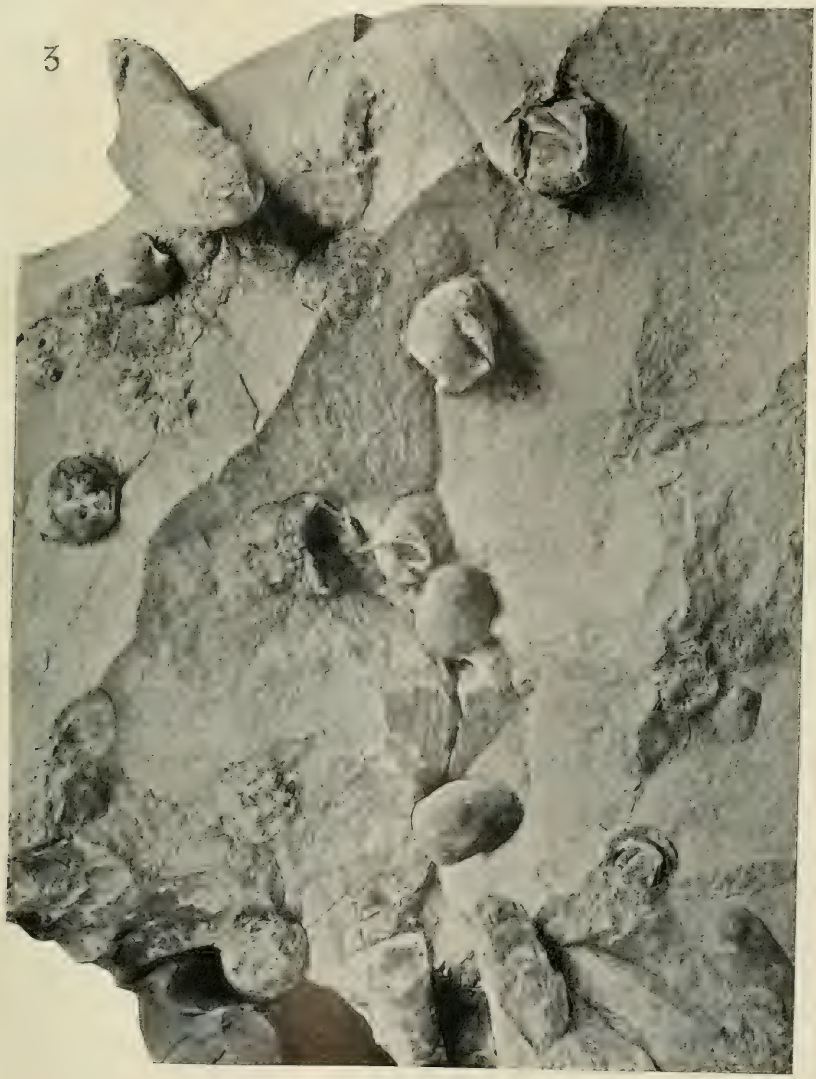
1



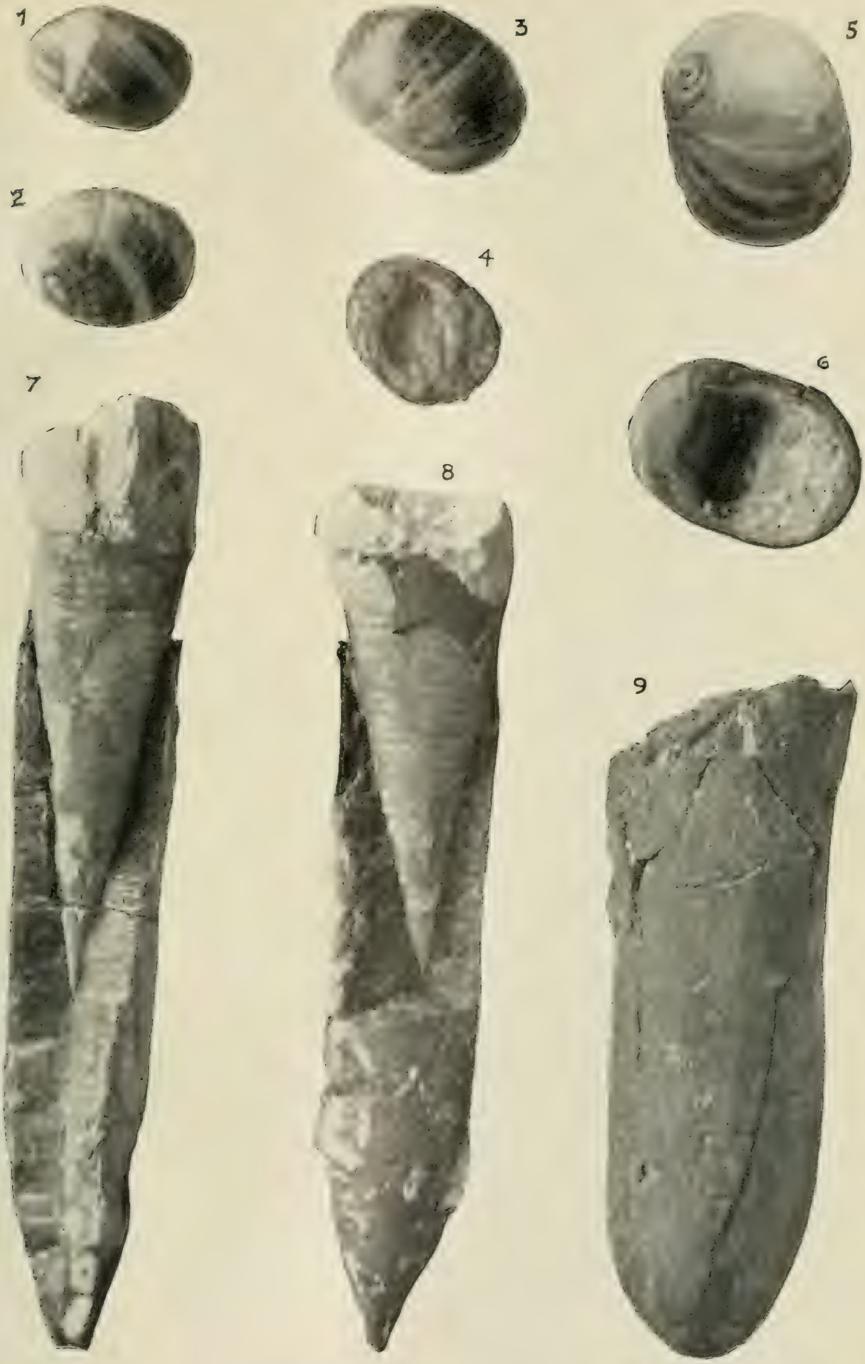
2



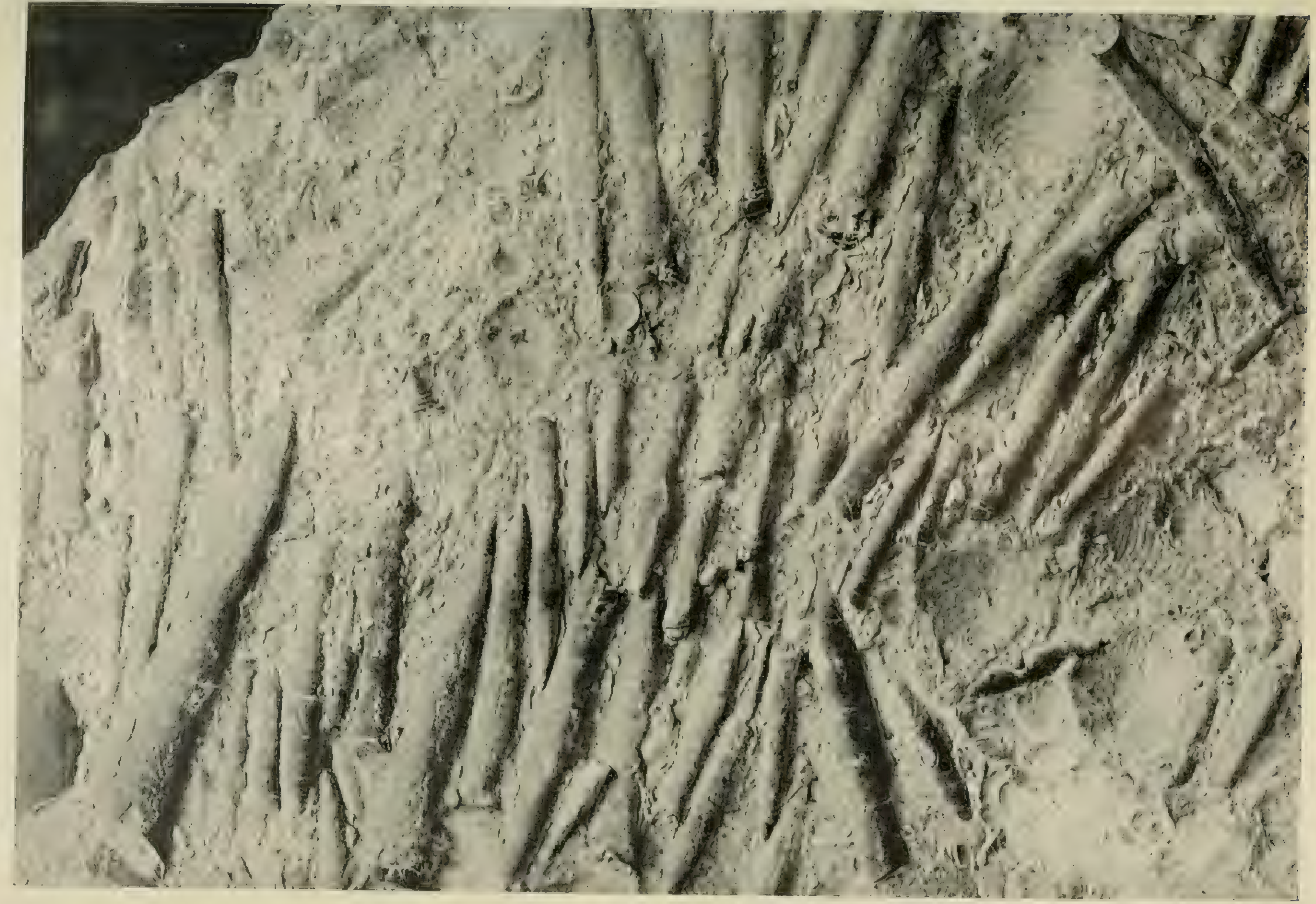
3



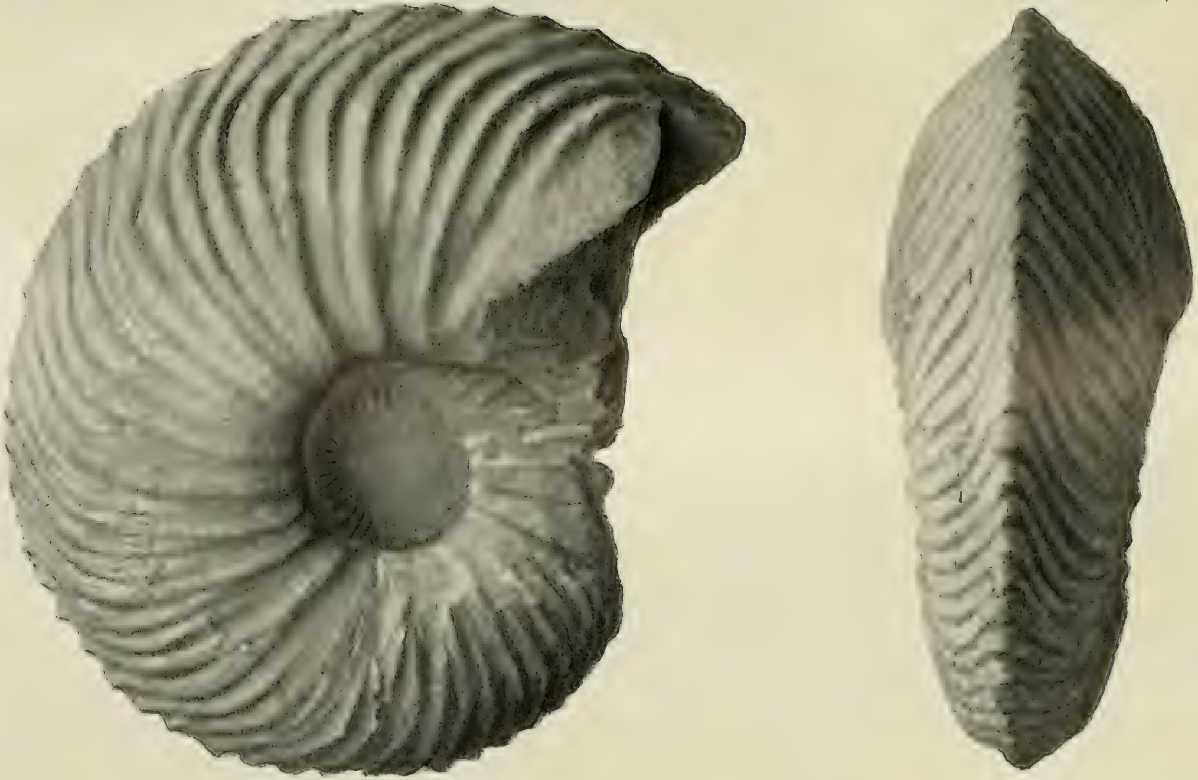
Black Hills Jurassic Fossils.



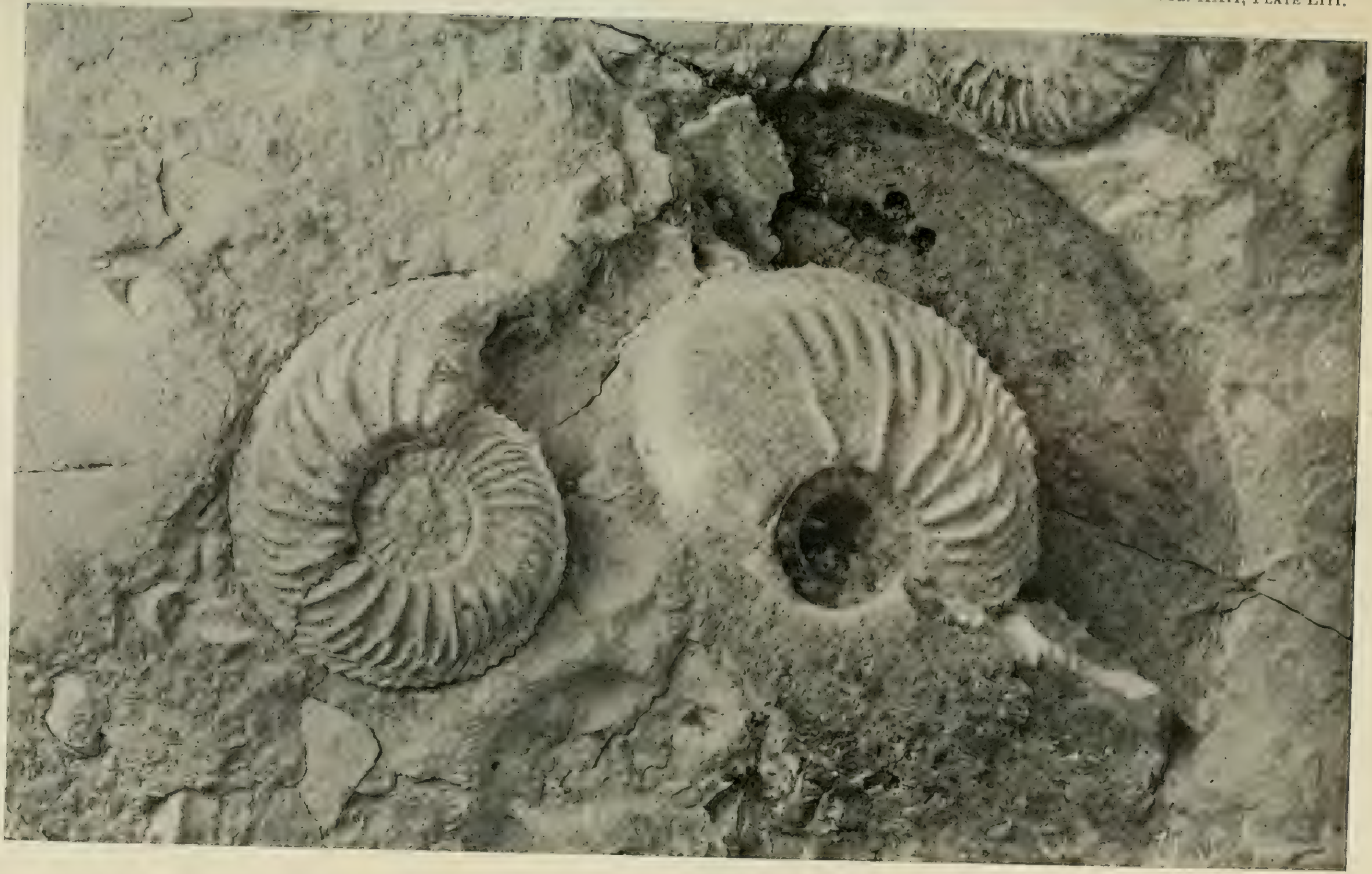
BLACK HILLS JURASSIC FOSSILS.



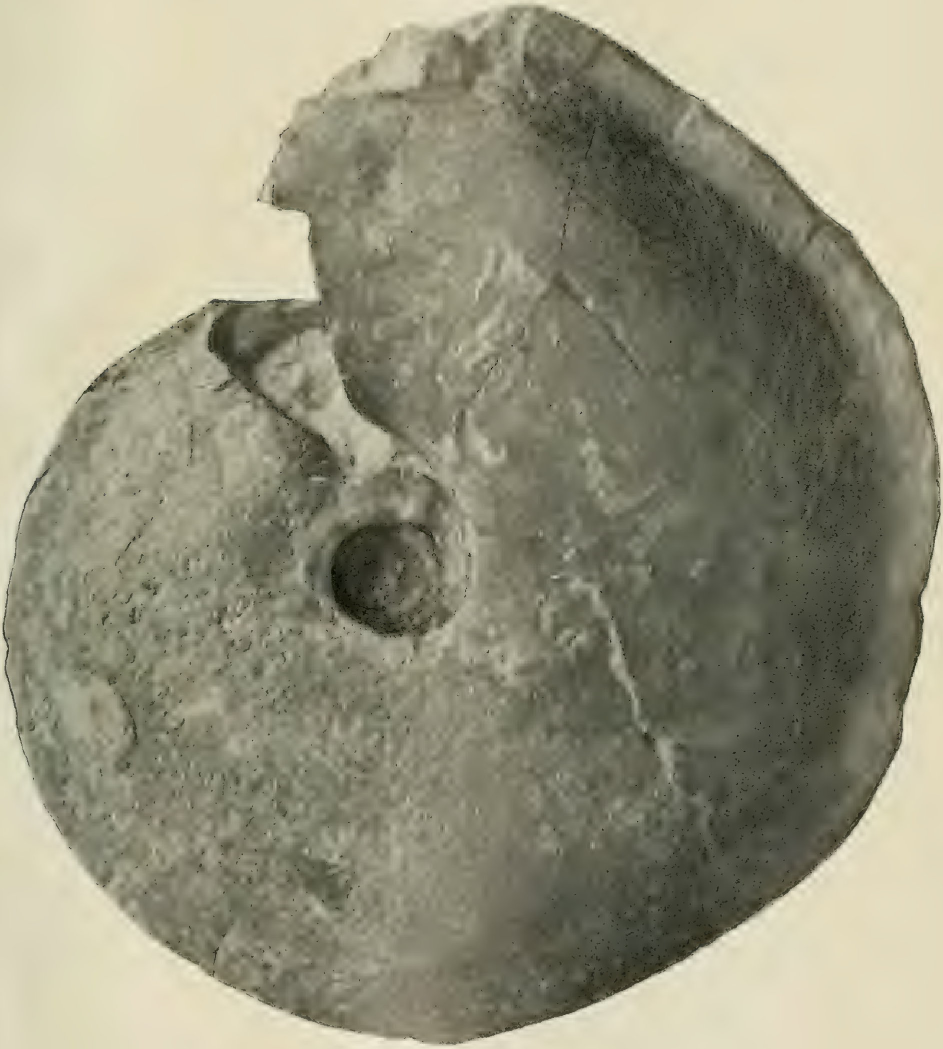
BLACK HILLS JURASSIC FOSSILS.



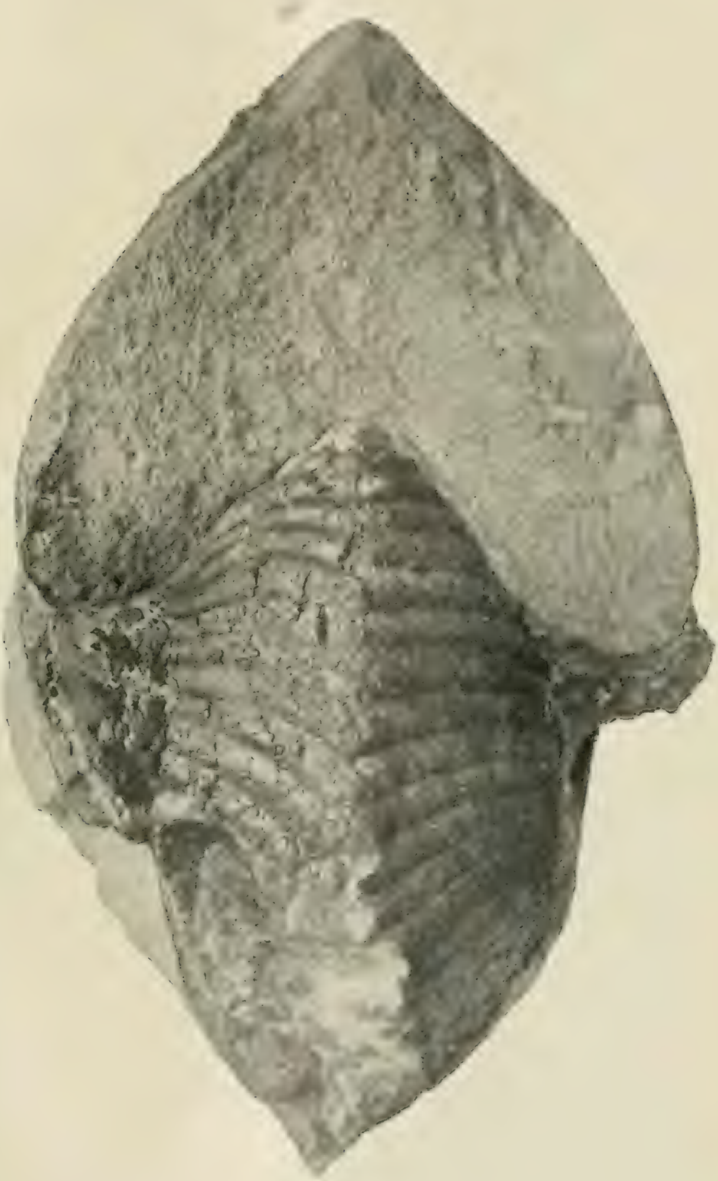
BLACK HILLS JURASSIC FOSSILS,



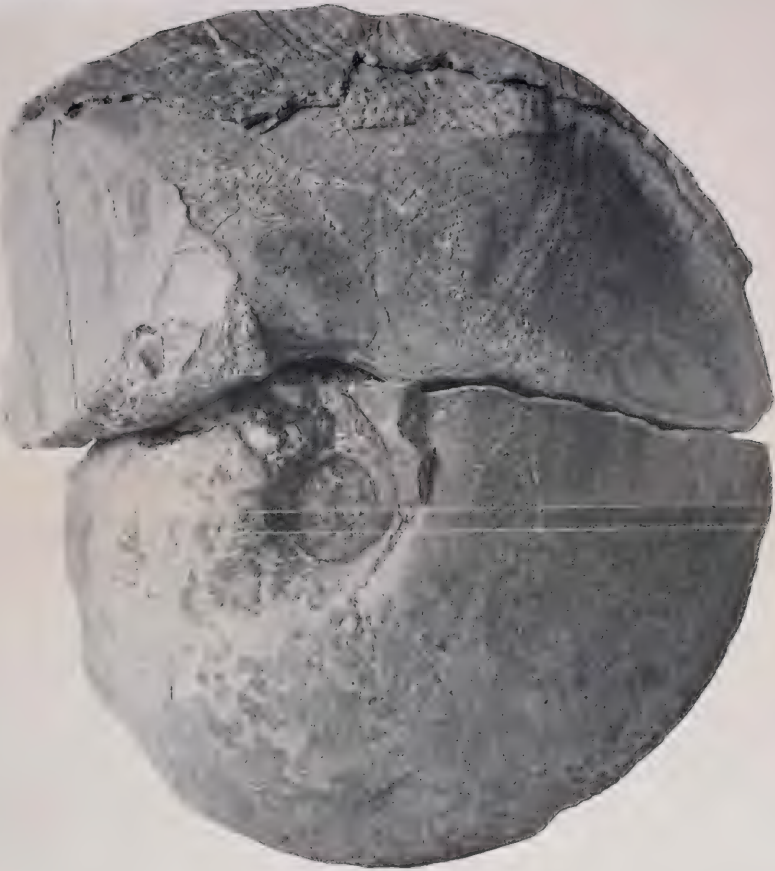
Black Hills Jurassic Fossils.



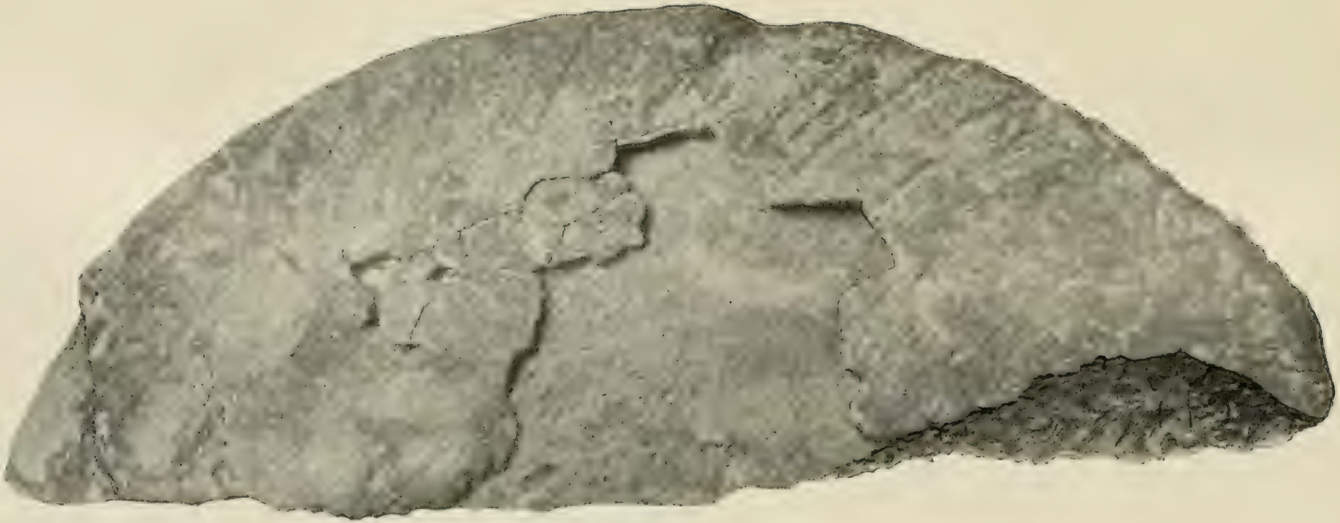
Black Hills Jurassic Fossils.



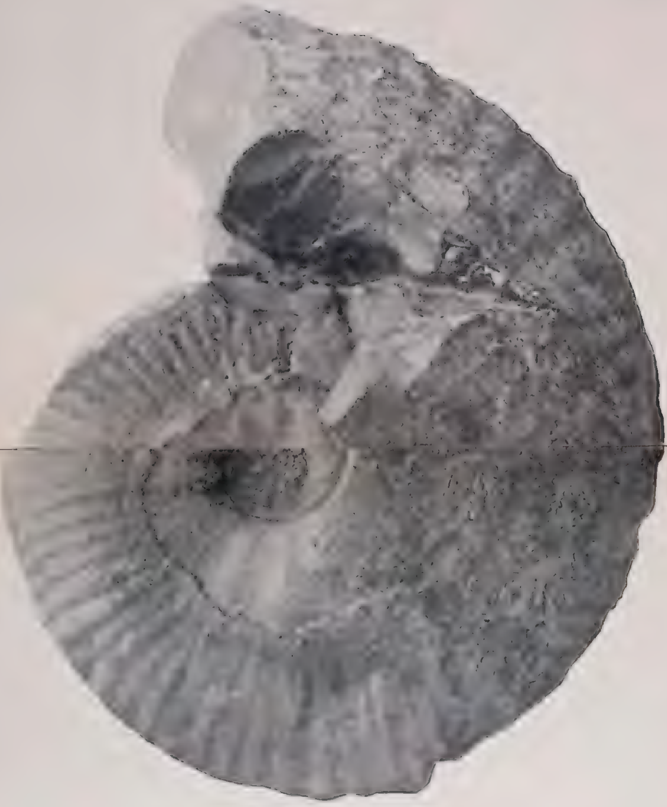
BLACK HILLS JURASSIC FOSSILS.



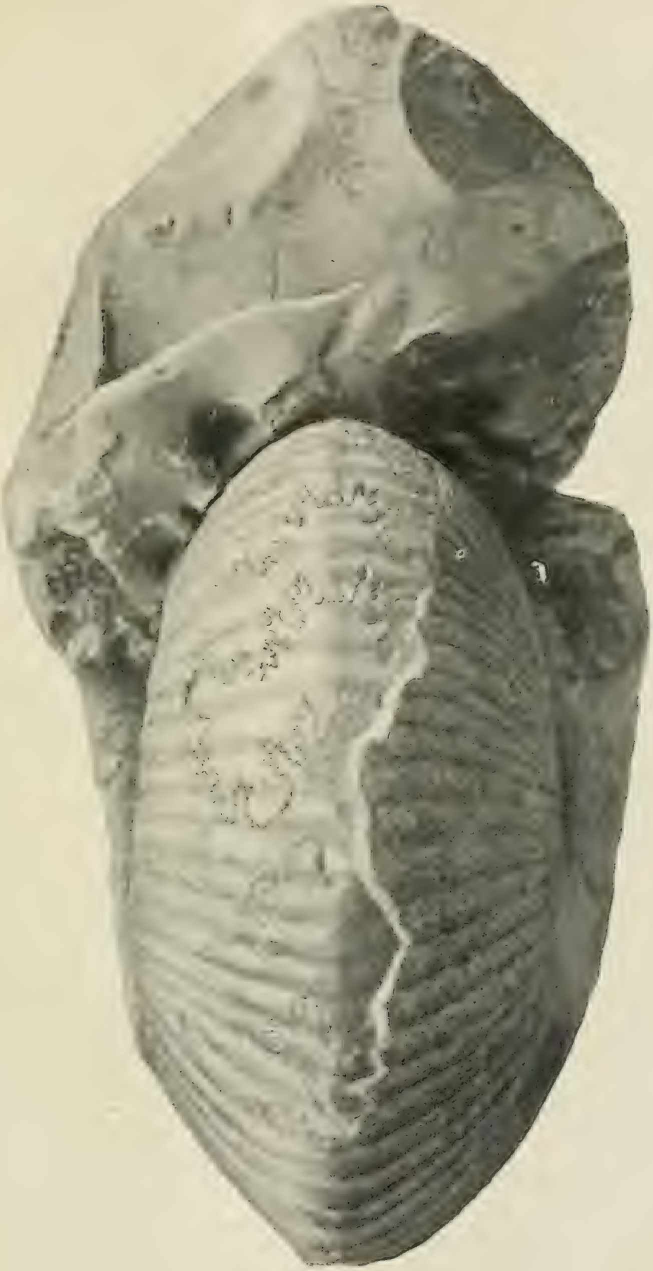
Black Hills Jurassic Fossils.



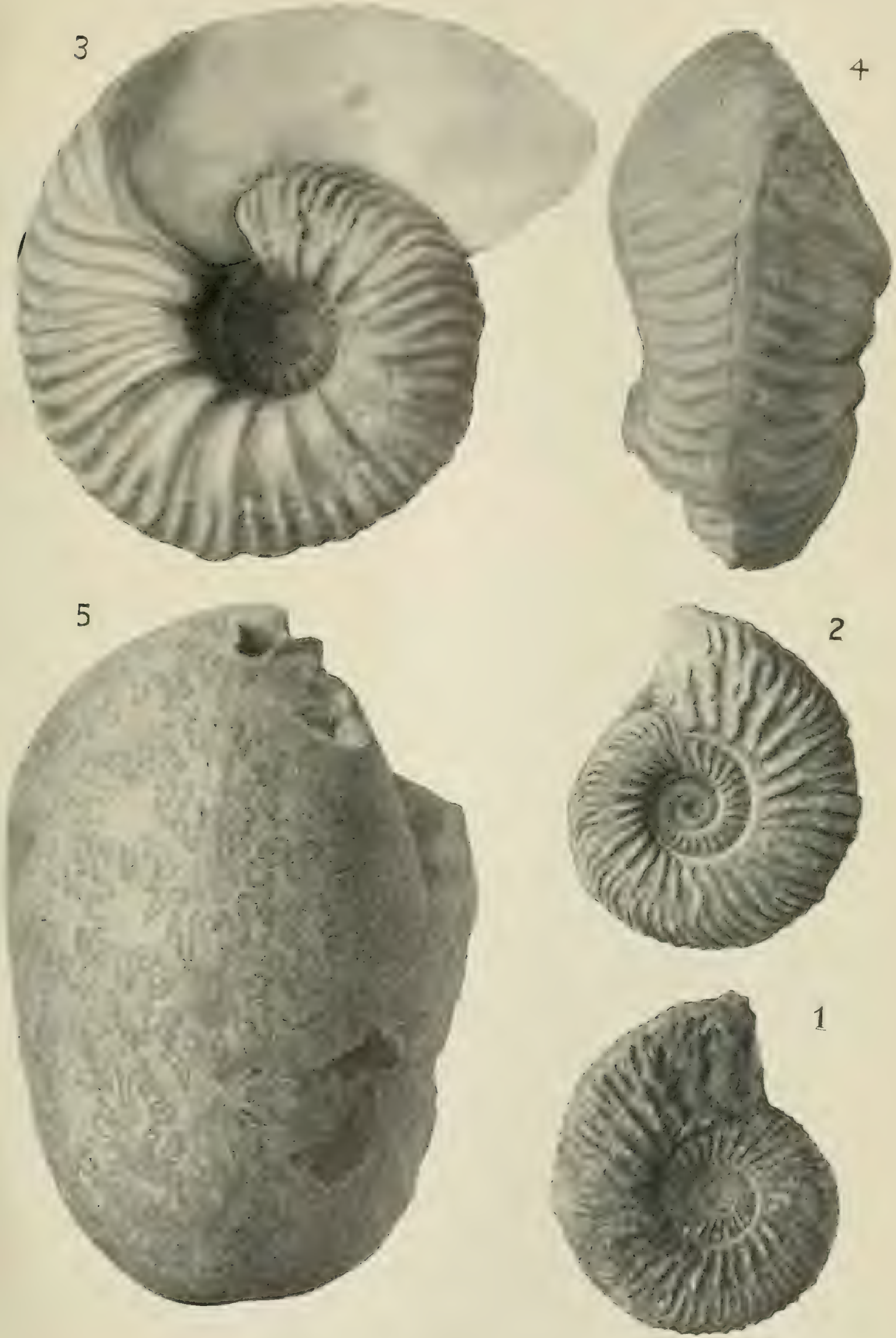
Black Hills Jurassic Fossils.



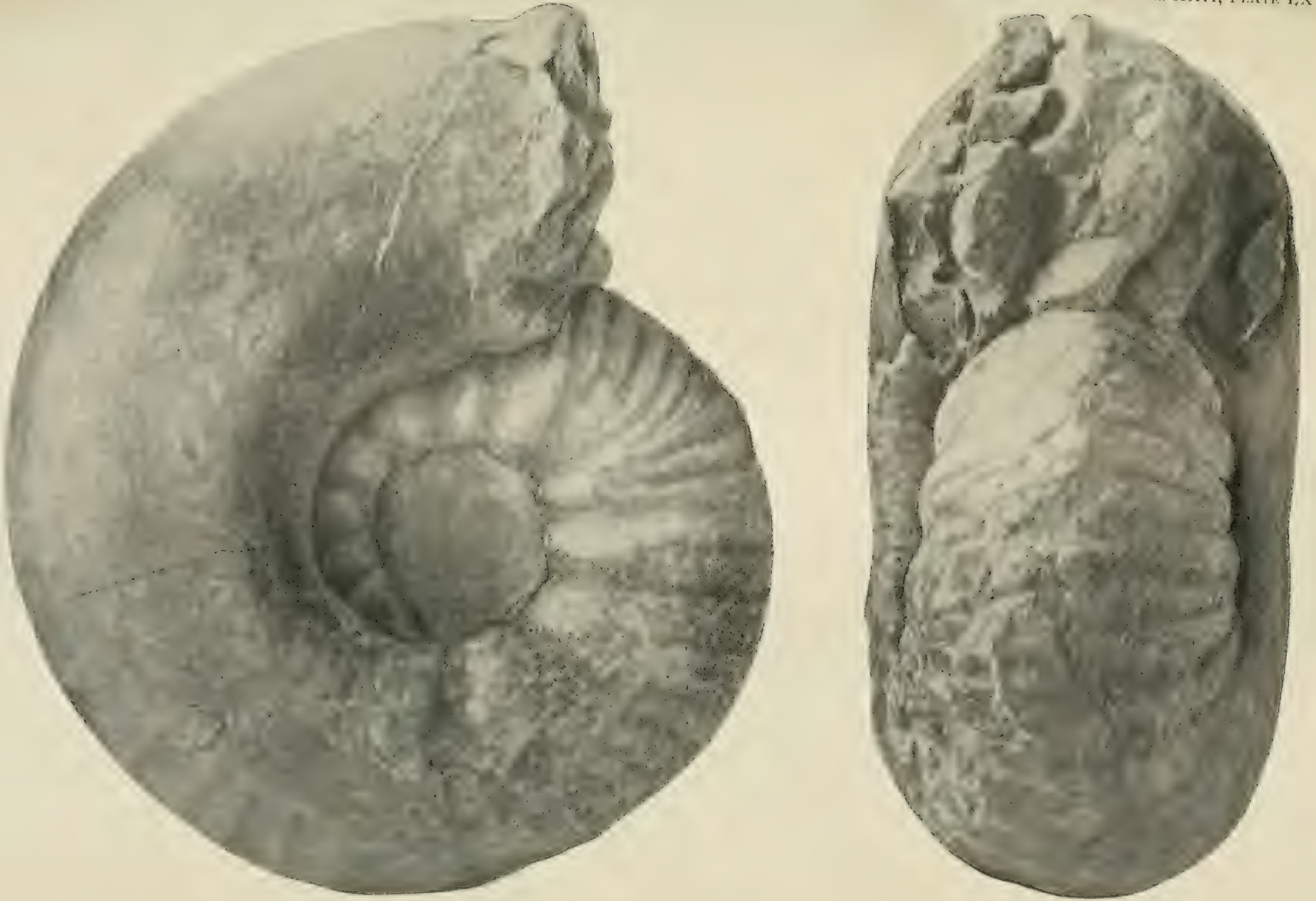
[illegible]



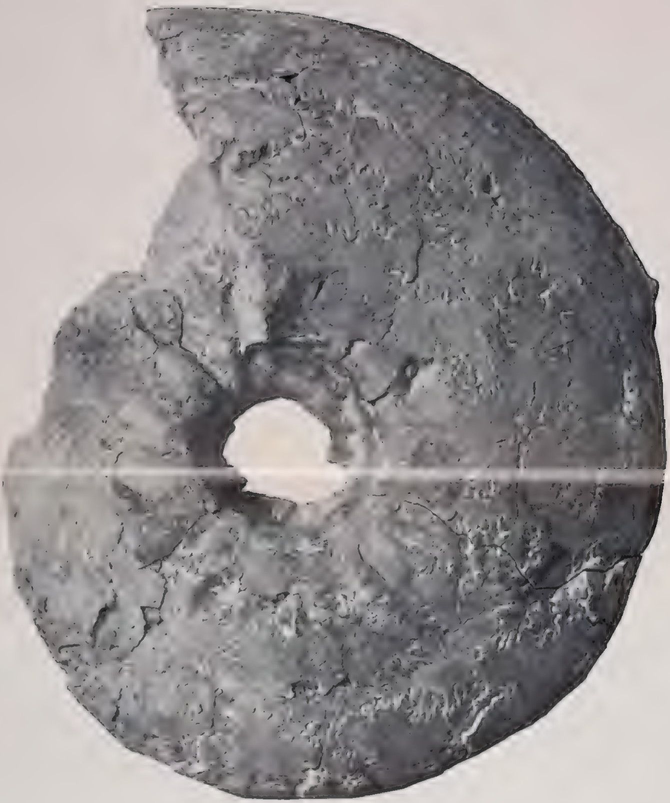
Black Hills Jurassic Fossils.



BLACK HILLS JURASSIC FOSSILS.



Black Hills Jurassic Fossils.



BLACK HILLS JURASSIC FOSSILS.

59.57,96:15

Article XXIV.—AN ETHOLOGICAL STUDY OF CERTAIN MALADJUSTMENTS IN THE RELATIONS OF ANTS TO PLANTS.

By William Morton Wheeler.

Plates LXIII–LXVIII.

Much has been written concerning the mutual helpfulness of certain species of ants and plants, but very little attention has been bestowed on the cases in which these organisms live together in a state of imperfect adaptation or antagonism. And yet such conditions may be expected to exist as the preliminary stage, if nothing more, in the course of development leading to such complete and harmonious adjustments as we witness in the symbiosis of certain ants, like the American Attii, with the fungi which they not only systematically cultivate but carefully transmit from mother to daughter colonies generation after generation. In the following article I have collected a few cases which seem to me clearly to prove the existence of a struggle between the ants and their plant environment, a struggle in which the ants, notwithstanding their notorious adroitness in surmounting obstacles to their welfare, seem always to succumb.

I. THE MOUND-BUILDING ANT AND THE HAIR-CAP MOSS.

Some months ago Mr. W. D. W. Miller of the American Museum of Natural History called my attention to a beautiful colony of the mound-building ant of the Alleghenies (*Formica exsectoides*) near Scotch Plains, New Jersey. This colony, which Mr. Miller visited with me during May and June, is situated in a wood on flat clayey soil, at an altitude of about 150 meters. The nests, forty to fifty in number, are scattered over an area of less than a square kilometer and are all built in open, sunny clearings among the trees. There are nests in all stages of growth, from their first inception to old extinct mounds covered with moss and other plants. The worker ants, in full possession of the surrounding woods, are everywhere to be seen, running about on the ground in search of dead and disabled insects, and climbing the trees and bushes for the purpose of collecting the honey-dew from the droves of aphids and membracids. Though less numerous, the nests near Scotch Plains compare very favorably in size with those of the famous colony near Hollidaysburg, Pennsylvania, described nearly thirty years ago by McCook.[1] With the aid of my assistant, Mr. Roy E. Miner, I measured eleven of the largest mounds and record their height, transverse diameter through the base and over the summit and the circumference in meters and in feet, in the following table:

No.	Height.			Basal Diameter			Diameter over Summit.			Circumference.		
	m.	ft.	in.	m.	ft.	in.	m.	ft.	in.	m.	ft.	in.
1.	.90	2	11.3	1.40	4	6.9	1.91	6	2.9	4.398	14	4.4
2.	.77	2	6.2	2.65	8	7.9	2.85	9	3.7	8.325	27	2.4
3.	.48	1	6.8	2.23	7	3.4	2.61	8	6.3	7.005	22	10.6
4.	.77	2	6.2	2.36	7	8.5	2.64	8	7.4	7.414	24	2.6
5.	.85	2	9.3	2.45	8	.04	2.92	9	6.5	7.696	25	1.6
6.	.95	3	1.2	3.61	11	9.5	4.00	13	.8	11.341	37	.6
7.	1.00	3	3.2	3.25	10	7.4	3.84	12	6.5	10.21	33	4.2
8.	.70	2	3.4	2.46	8	.4	2.61	8	6.3	7.728	25	3.
9.	.58	1	10.7	1.79	5	10.2	2.12	6	11.1	5.623	18	4.4
10.	.80	2	7.4	2.23	7	3.4	2.53	8	3.2	7.005	22	10.6
11.	.73	2	4.6	2.04	6	.10	2.43	7	11.3	6.408	20	11.2

The average height of these mounds is .78 m. (2 ft. 6.5 in.) with a basal diameter of 2.40 m. (7 ft. 10 in.), a convex diameter of 2.77 m. (9 ft. 5 in.) and a circumference of 7.55 m. (24 ft. 7.9 in.). They exhibit considerable differences in shape, some being more pointed or conical, others more depressed and rounded. Although unusually well developed, none of these hills reaches the dimensions of one measured by McCook (*l. c.*, p. 255). This, the largest on record, was 1.07 m. (3 ft. 6 in.) in height, 7.34 m. (24 ft.) in diameter over the summit, and 17.75 m. (58 ft.) in circumference.

The mounds of *F. exsectoides* undoubtedly answer the same purpose as those of *F. rufa* in Europe and certain of its varieties in this country. As Forel has shown, these accumulations of detritus serve as incubators for the brood, since their temperature during the day is, of course, much higher than that of the underground portions of the nests. Unlike the mounds of *F. rufa*, however, those of *F. exsectoides* consist very largely of earth and only to a very limited extent of vegetable detritus and pebbles. McCook is certainly in error when he writes (*l. c.*, p. 270) that "every hill furnishes a fair measure of the extent of the underground system of galleries connected therewith; for it is reasonably certain that the entire bulk of soil in each mound has been excavated and brought from the galleries beneath the surface." On the contrary, it is probable that much of the earthen material of the mounds, like all the vegetable detritus, is collected by the foraging workers from the surface of the area surrounding the nest. This material is brought together and built into the mound in the very same manner as the harvesting ants *Pogonomyrmex barbatus* and *P. occidentalis* collect their pebbles, and *F. rufa* its vegetable detritus. The interior of the mound of all these ants is riddled with galleries in which the larvæ and pupæ can be kept during the warm hours of the day for the purpose of accelerating their development.

---

[1] Mound-building Ants of the Alleghenies. Trans. Am. Entom. Soc., VI, 1877, pp. 253–296, 1pl. ii–vi 13 text-figs.

It is not only an easy matter to observe any of our mound-making ants in the act of picking up and carrying materials to its nest, but the nature of the materials in certain localities is indisputable proof of such activity. Along the railroad tracks through Indiana, Ohio, and western New York, may be seen dozens of mounds of *F. fusca* var. *subsericea* covered with a thick layer of locomotive cinders that have been carefully collected by the worker ants. Even more striking is the same habit in *Pogonomyrmex barbatus* var. *molefaciens* along the railways of Texas, and in *P. occidentalis* in similar situations in Colorado and New Mexico. The large nest cones are often so black with cinders as to stand out in very sharp contrast with the pale surrounding soil. Along the Chicago, Burlington & Quincy R. R. for many miles east of Denver, Colorado, the nest cones of *occidentalis* close to the track are deep black, while those further away, to a distance of about thirty or forty meters, show a gradual fading in color, with the decrease in available cinders, to the light-colored nests of the open plains beyond. Recently, while collecting ants near Florissant, Colorado, I came upon a colony of three nests of *F. exsectoides* var. *opaciventris*. One of these, near the Colorado and Midland R. R. track, was heavily covered with cinders like the nest cones of *P. occidentalis* above described. Cinders in such situations are, of course, very suitable material for retaining the sun's heat, but it would be going too far to attribute to the ants any knowledge of their value in incubating the brood. Any particles of such a size and shape as to be conveniently carried to the nest, will be collected by these indefatigable insects. At Ash Fork, Arizona, I found some of the cones of *P. occidentalis* covered with the dung-pellets of spermophiles, and Wasmann has recently observed a similar habit on the part of the European *F. pratensis*, which, in certain localities, covers its nest with the dung-pellets of rabbits and the dried flower-heads of *Centaurea*.

Even more interesting than the dimensions and composition of the *exsectoides* nests is the fact that they show very clearly some of the conditions which lead to their ultimate decay and abandonment by the ants. Observations made near Scotch Plains, together with those I have collected in some other localities (Staten Island, Highland-on-Hudson, Colebrook, Conn.), show that these structures pass through the following evolutionary and involutionary stages:

1. The incipient nest. In a previous article[1] I maintained that nests of *F. exsectoides* may be established in two different ways: first by the association of a recently fertilized female with workers of her own species from the maternal or some neighboring colony, and the emigration of the company thus formed, followed by the construction of a new nest in a different locality, and second, by the association of a recently fertilized female with an effete or queenless colony of the common black ant (*F. fusca* var. *subsericea*). In the latter case the female remains with the host species until her first brood of workers matures and the host workers have perished. Then, the object of this temporary parasition having been accomplished, the pure *exsectoides* colony is able to multiply rapidly and without extraneous assistance. In this, the earliest stage in the development of the colony, the nest is, of course, that of *F. subsericea*, a low obscure mound overgrown with long grass and perforated with numerous entrances. Even when the colony is pure from the start, however, that is, when a young female associates herself with workers of her own species, the nest is of this same character as shown in my former paper (*antea*, Pl. XII, Fig. 1). Similar nests were seen in the Scotch Plains colony in close proximity to the large mounds.

2. As the ants keep enlarging their nest it takes on a somewhat different appearance. They deposit large quantities of earth and vegetable detritus on the summit of the mound and kill off the grass in this region, so that the mound comes to have a bare summit and is surrounded by a broad belt of tall grass This grass belt, to which the numerous openings of the nest are largely confined, is usually thinned out by the ants to admit the sun's light and warmth to the soil in which it grows. Two young nests of this description are represented in my former paper (*antea*, Pl. XIII, Figs. 1 and 2). The grass zone is occasionally retained until the nest reaches a large size. This is the case in the one figured on Pl. LXIII, which is No. 11 of the table on p. 404.

3. Most nests, however, that have attained a large size and are

---

[1] On the Founding of Colonies by Queen Ants, with Special Reference to the Parasitic and Slave-making Species: Bull. Am. Mus. Nat. Hist., XXII, 1906, pp. 33–105, pll. viii–xiv.

inhabited by colonies or parts of colonies at the acme of their prosperity and development, are completely or almost completely free from grass. There can be no doubt that this vegetation usually succumbs to the sharp mandibles of the ants. A number of nests of this description, appearing as compact earthen mounds, covered only with a small quantity of vegetable detritus, were seen in a large clearing near Scotch Plains. Four of these are shown in Pl. LXIV. They were all smaller than any of those measured for the above table.

4. This stage is characterized by a growth of moss which first makes its appearance in a narrow band around the extreme base of the mound just above a shallow, moat-like depression about 20 cm. in diameter which often encircles the nest and separates it from the surrounding surface. This moss is *Ditrichum pallidum*,[1] a species which is too small and delicate to interfere with the activities of the ants. In the course of time it is partly or completely supplanted by a larger and more vigorous species (*Polytrichum commune*), which begins to form a densely tufted zone around the base of the mound. This moss is rarely found in the woods near Scotch Plains except on the ant-hills, and I was at a loss to account for its singular distribution till Mrs. Britton informed me that it is preëminently a bank-loving species. As the soil of the woods is very level, the plant naturally takes to the only bare elevations in the vicinity. It is not improbable that the *Ditrichum* may in some way prepare the soil for the growth of the *Polytrichum*. Pl. LXV represents the largest nest in the colony (No. 8 of the above table), which had a zone of *Ditrichum* 10-20 cm. broad around its base, but too delicate to show in the photograph. Plates LXVI, LXVII, and LXVIII show that the *Polytrichum* zone continually widens until only a small area at the summit of the mound, the umbilicus, is left uncovered. In Plate LXVII it has invaded a nest which retained a well developed grass zone, but this is evidently destined to disappear before the advancing moss. Nests over which the *Polytrichum* carpet is far advanced are invariably depauperate. The ants are few in number and seem to be rather inactive, a condition undoubtedly attributable to the growth of the moss. This plant has very hard, tough stems and roots, which the ants are unable to sever, so that they cannot dispose of it as they do of grass and other plants. It chokes up the basal zone of entrances, or at any rate grows so densely as to make them

---

[1] For kindly identifying the mosses mentioned in this paper I am indebted to the well known bryologist Mrs. Elizabeth G. Britton.

inaccessible to the insects. The densely tufted moss is much like fur and seriously impedes the insects in going to and from the nest, so that in some nests invaded by the *Polytrichum*, a second zone of entrances had been constructed nearer the summit and along the inner edge of the moss zone. In one of the large twin nests (No. 6) shown in Pl. LXVI the ants constantly made a bridge of a fallen log running from the ground to the umbilicus. It is certain, moreover, that the moss, which absorbs and retains quantities of water and therefore reduces the temperature of its surroundings, must impair the usefulness of the mound as an incubator.

5. The *Polytrichum* carpet continues to grow at its upper edge until it envelops the summit of the mound and extinguishes the ant community. In one mound of this description, with an uncovered area only 20 cm. in diameter, a few lethargic ants still lingered in the earth of the summit; from other similar and older nests they had completely disappeared. While the dense carpet continues to expand, herbaceous, and even woody plants of many species begin to settle on the mounds and eventually in great part completely replace the moss. The mound subsides somewhat, probably owing to the collapsing of its galleries and chambers, and becomes flatter and less conical. It may still be recognized, however, after the lapse of years as was shown by one mound which supported bushes with stems 5–6 cm. in diameter. On these advanced nests at least three other mosses (*Dicranella heteromalla*, *Catherinea angustata*, and *Hypnum recurvans*) may be seen growing singly or in company.

Do the ants emigrate and seek a new nesting site when the invasion of the *Polytrichum* becomes intolerable, or do they gradually die off without deserting the mound which they have reared with such diligent solicitude? This is a difficult question to answer, because a single *exsectoides* colony may extend over several mounds and these may be connected by subterranean galleries. The fact that the ants in mounds invaded by *Polytrichum* have all the appearance of relicts smitten with the weariness and dejection so characteristic of old and depauperate ant communities, certainly favors the view that the insects die off *in situ*.

It is equally difficult at present to answer the question as to the time required to bring about the changes described in the above stages. The age limit of the nest was considered by McCook (*l. c.*, pp. 265–267), who concluded that he had "good reason to believe that some of the hills are at least thirty years old." This estimate is probably as close as any that can be obtained until some one actually watches the growth of a mound from its inception to its decay.

It would be important to know whether the above stages may be detected in the development of the *exsectoides* nests throughout the range of the species. Incidental remarks in McCook's work seem to indicate that the nests in Pennsylvania present the same peculiarities which I have described. He mentions (p. 254) twenty nests near Warrior's Mark, in Blair County of that State, as "abandoned and covered with moss and grass." And on page 256 he says: "Many a romance of ant life lies hidden within those silent moss-covered mounds." "I have thought that some of these abandoned hills have been reoccupied as they carry a moss-grown and ancient appearance, although in full activity."

For any observations corresponding to those recorded for the Scotch Plains colony it is necessary to turn to the works of European writers. Europe possesses a species of Formica (*F. exsecta*) which is not only so like *exsectoides* in color and structure as to have suggested the name of the American species, but is also very similar in some of its habits. These have been studied by Forel,[1] Wasmann,[2] and more recently by Holmgren.[3]

F. exsecta lives in bogs and meadows, at lower altitudes in the north but in southern Europe on high hills or mountains. According to Wasmann, "The architecture of the nest is, generally speaking, a small edition of that of the fallow ant (*F. rufa*), both in regard to its dimensions and the materials employed. It consists of much finer substances, dried grass-blades, heather leaves, etc., and contains a much greater admixture of earth. The heaped-up vegetable detritus, so characteristic of all so-called 'ant-hills,' forms in this case only the top; beneath it lies a layer of densely felted grass-stems, grass-roots and soil, in which the true galleries and the chambers of the nest are excavated and whence they extend further down into the earth. The form of the nest is that of a strongly truncated cone. Almost never have I seen nests, either in Vorarlberg or in the Rhineland, with an arched dome like that of *F. rufa*, but almost invariably only such as had a flat top like that of *F. pratensis*. In mountain meadows the cone is sometimes 50 cm. or more in height, its circumference 1 or even 1.5 m. The cone of the *exsecta* nest is, speaking more precisely a crater, consisting of soil and felted plant growth, filled in at the top with dry vegetable detritus. The nests therefore belong to Forel's 'combination nests,' in which an earthen substructure is combined with a superstructure of plant detritus. The *exsecta* nest is peculiar in having the earthen portion much more extensive than the top and enclosing it like a crater."

---

[1] Les Fourmis de la Suisse. Zürich, 1874, pp. 191, 192.

[2] Formica exsecta Nyl. und ihre Nestgenossen. Verhand. naturhist. Ver. Rheinl. Westf., 1894, I Heft.

[3] Ameisen (*Formica exsecta* Nyl.) als Hügelbildner in Sümpfen. Zool. Jahrb., Abth. f. Syst., XX, 1904, pp. 353-370, 14 text-figs.

The development and decay of the nests of this ant have been studied near Aborrträsk in Gellivare, Lapland, with results that show a remarkable similarity to the conditions above recorded for the American *exsectoides*, if we make due allowance for the fact that the European ant nests in damp meadows or bogs whereas our American species prefers dryer soil or even hill-slopes covered with open woods.[1]

I here reproduce the summary of Holmgren's observations:

"1. The ant-hills in the willow zone are larger, but less numerous than those in the *Sphagnum* zone of the bogs. The greater size depends on the accessibility to more abundant building materials. Their smaller number is likewise attributable to the same conditions, since a greater number of ants are constrained to secure their food and building materials in a relatively small area. Migration for the purpose of founding new nesting sites is unnecessary on a large scale where food and especially building materials are abundant. Access to an abundance of the latter also explains the fact that in the willow zone the nests are not overgrown by *Polytrichum strictum*, for here the ants can inhibit the invasion of the moss by uninterrupted building.

"In the *Sphagnum* zone, however, building materials are scarce and on this account the ant colonies must be smaller and migration occurs on a larger scale. This accounts for the smaller size and greater number of ant-hills in this zone.

"In the damp bog, building materials are relatively very scarce. Here the hills are very much reduced in size and number. Owing to the moisture in this zone there are few spots that will permit the ants to build hills, for these insects require rather dry soil in which to establish themselves.

"2. The position of the hills in damp places prevents the ants from establishing any large general trails when they go forth to forage. Where the base of the nest is completely surrounded by water, they are either completely isolated or must climb from leaf to leaf along the plants until they reach *terra firma*. In general, such hills undergo no further additions to their bulk.

---

[1] There are in America two other forms closely related to *F. exsectoides*, namely *F. exsectoides* var. *opaciventris* Emery and *F. ulkei* Emery. The former is known only from Colorado, where it nests in dry, open situations at an altitude of 6000–8000 ft. Its nest-cones resemble those of the typical *exsectoides* in shape but are covered with pebbles instead of vegetable detritus. *F. ulkei* which is unquestionably a boreal species, was originally described from South Dakota, but I have recently received worker and female specimens from Nova Scotia. Its nesting habits are unknown but probably resemble those of *exsecta* or *exsectoides*.

"3. Plants are rather quick to gain a foothold on the ant-hills. The first and main vegetation of the nests is *Polytrichum strictum*, which forms a dense carpet. The condition which leads this moss to its invasion is the comparative dryness of the nest. The *Polytrichum* carpet gradually spreads until it completely covers the hill.

"4. The remaining plants that creep up onto the hills usually belong to species growing in the immediate neighborhood. Other plants are rarely found and these grow on the umbilicus or summit which they have reached as seeds and where they have found a place suitable for germination.

"5. The outer form of the ant-hill depends on the carpet of *Polytrichum*. If this moss advances onto the hill from the side, the substance of the nest flows over, so to speak, onto the opposite side In other words, the ants continue to add to the mound on the uninvaded side. One observes, moreover, that the nest-substance always spreads in the directions where the moss carpet is least developed. In other words, the ants withdraw as the *Polytrichum* carpet advances.

"6. Owing to the conditions stated in the preceding paragraph, the basal portions of the ant-hill are abandoned by the ants *pari passu* with the advance of the carpet. This takes place step by step. The ants do not leave the basal portions till the carpet has risen too far. This explains why the inhabited portions of the nest extend down deepest into the hill where the diameter of the umbilicus is greatest.

"7. Another result of the invasion of the *Polytrichum* is the pronounced reduction in the number of ants in the hill due to emigration, since they are unable to add to the mound, while its habitable portion is continually growing smaller. These conditions account for the greater number of ant-hills in the zone of *Sphagnum* hummocks.

"8. When the *Polytrichum* carpet has reached a certain height the ants cease to build. This follows directly from the preceding paragraph.

"9. The *Polytrichum* carpet steadily advances till it displaces the ants completely.

"10. The apparent aversion shown by the ants for the inner portions of the hill already covered by the *Polytrichum* is due to the fact that the moss attracts and retains water, so that these portions become rather moist and therefore unsuitable as a dwelling for the insects.

"11. It follows as a general conclusion from paragraphs 5–10 that there must be between the *Polytrichum* and the ants a severe struggle in which the moss is always victorious.

"12. *Sphagnum* often gains a foothold on the hill before the *Polytrichum* has completely overgrown the summit, or umbilicus. *Sphagnum*, generally speaking, displaces *Polytrichum*. This is certainly the case wherever the *Polytrichum* hills have not been destroyed. From this follows:

"13. The *Polytrichum*-hummocks are converted into *Sphagnum*-hummocks through a displacement of the former by the latter moss; and this is the end-product of the ant-hills.

"The most general conclusion reached in the foregoing paragraphs is that the ants play an important rôle in the formation of hummocks in the bogs under consideration, since the hills serve as growth-foci for the moss and peat vegetation."

Holmgren has also observed that in Lapland the nests of another ant (*F. rufa*) are gradually overgrown by boreal plants (*Vaccinium vitis idæa*, *myrtillus* and *uliginosum* and *Rubus chamæmorus*). In this case also the plants creep upward from the base of the hill, gradually driving the ants to the summit and eventually extinguishing the colony.

According to a footnote in the excellent work of my friend Dr. K. Escherich of Strasburg[1] a struggle between ants and mosses like that recorded by Holmgren and myself seems to occur in certain parts of Germany. He says: "Dr. A. Ludwig brought me from a bog in Grunewald near Berlin a number of dried masses of *Polytrichum strictum*, the basal half of which was perforated with chambers and galleries. The inhabitants of these, a species of *Myrmica*, are driven out by the increasing moisture due to the gradual intrusion of water-storing *Sphagna*." Escherich also mentions similar observations made by Kuhlgatz in the bogs of Western Prussia.[2]

Whether a similar displacement of ants by mosses occurs among such American bog-ants as *Myrmica rubra brevinodis*, which, as I have shown in a former paper,[3] nests in hummocks of *Polytrichum commune*, and *Formica cinerea* var. *neocinerea*, which I have found nesting in large grassy hummocks in meadows from Colorado to Illinois, must be determined by renewed observations.[1]

---

[1] Die Ameise. Schilderung ihrer Lebensweise. Braunschweig, 1906, 232 pp., 68 text-figs.

[2] Vorstudien über die Fauna des Betula nana-Hochmoores im Culmer Kreis in Westpreussen Nordd. Wochenschr., n. F. I, 1902, p. 613.

[3] Ethological Observations on an American Ant (Lepthorax Emersoni Wheeler), Arch. f. Psych. u. Neurol., II, 1903, pp. 1–31, 1 fig.

2. THE TENT-BUILDING ANT AND THE PITCHER PLANT.

While engaged in making the observations on the habits of the tent-building ant (*Cremastogaster lineolata*) recorded in a former article[2] I came upon another instance of maladaptation very different from that described in the preceding paragraphs. The tent-building ant is one of the most plastic and adaptable of our North American Formicidæ. This is shown both in its wide variability over an extensive geographical range and in its ability to construct, often at a considerable distance from its nest, beautiful carton or earthen tents over its herds of aphids and coccids. We should expect such an ant to be more than ordinarily skilful in evading or circumventing the wiles of inimical plants. This, however, seems not to be the case. While examining the pitcher-plants (*Sarracenia purpurea*) in the bogs about Lakehurst, New Jersey, I found the ascidia, or pitchers, in many cases partially filled with the dead remains of *Cremastogaster lineolata pilosa*, a subspecies which seems to be characteristic of boggy spots in the pine barrens. Undoubtedly thousands of workers of this ant are annually destroyed and consumed by these apparently passive insect-eating plants.

The extremely interesting devices whereby the plants of the North American genus *Sarracenia* are able to entrap great numbers of insects, have been described by several botanists, notably by Vogt,[3] Hooker,[4] Mellichamp,[5] Schimper,[6] Zipperer,[7] Macfarlane,[8] and Meehan.[9] Macfarlane, especially, has gone into the subject in considerable detail and has given many figures illustrating the development and structure of the pitchers in all the species of *Sarracenia* (*S. flava*,

---

[1] The Occurrence of *Formica cinerea* Mayr and *Formica rufibarbis* Fabr. in America Amer. Natur., XXXVI, 1902, pp. 947–952.

[2] The Habits of the Tent-building Ant, *Cremastogaster lineolata* Say. Bull. Am. Mus. Nat. Hist., XXII, 1906, pp. 1–18, pl. i–vi.

[3] Phytohistologische. Beiträge, II, Die Blätter der *Sarracenia purpurea* Linn. Sitzber. K. K. Akad. Wien, 1865, I Bd. pp. 281–300, 2 Taf.

[4] Address to the department of Botany and Zoölogy. Report 44th Meet. Brit. Assoc. Adv. Sci. Belfast (1874) 1875, pp. 102–116

[5] *Sarracenia variolaris*. Amer. Natural., XI, 1877, pp. 432–433.

[6] Notizen über insectenfressende Pflanzen. Botan. Zeitg., 40 Jahrg., 1882, pp. 226–234, 242–248.

[7] Breitrag zur Kenntniss der Sarraceniaceen. Munich, 1885.

[8] Observations on Pitchered Insectivorous Plants. Part I, Ann. [Botan., 1889–1890, pp. 253–266, pl. xvii; Part II, *ibid.*, 1893, pp. 403–458, pl. xix–xxi.

[9] *Sarracenia variolaris*. Meehan's Monthly, IV, 1894, p. 1, 2. pls.

drummondi, *rubra*, *variolaris*, *purpurea*, and *psittacina*.[1] While the general structure is the same in all of these, there are interesting differences in detail in the various species. In all the outer surface of the pitchers is furnished with scattered, honey-secreting cells, which Macfarlane appropriately calls "alluring glands," since they attract the insects, especially the ground-loving species, like the ants, and lead them to the orifice of the pitchers. In *S. purpurea* there are small upwardly directed hairs on the outside of the pitchers, while the inside presents a series of surfaces modified in such a way as to lead the insects to their death in the liquid contained in the bottom. For these surfaces Macfarlane has adopted the names proposed by Hooker. The uppermost portion of the pitcher lining, the so-called attractive surface," is covered with short downwardly directed hairs. Below this there is a smooth slippery surface ("conductive surface") which is succeeded in turn by a densely "glandular surface" not represented in the other species of the genus. And finally the lowermost region presents a "retentive surface" furnished with long downwardly directed hairs. The hairs on the attractive and retentive surfaces prevent the insects from returning to the mouth of the pitcher, while the smooth conducting surface coöperates in offering a very insecure foothold, so that the insects fall into the liquid, usually present in the bottom, and are there eventually digested and in part absorbed by the plant tissues.

The prevalence of ants in the bottom of *Sarracenia* pitchers has been noticed by several observers. Mr. E. Daecke informs me that he has seen these organs of *S. purpurea* half full of dead *Cremastogaster* workers in the bogs near Bamber Station, New Jersey. Riley,[2] after describing the pitcher of *S. variolaris* of the Southern States, says: "The insects which meet their death in this pitcher comprise numerous species and of all orders; but as one might naturally infer, the ubiquitous, honey-loving ant is the principal victim." And Macfarlane makes a similar observation on our northern form: "I have had the opportunity of examining *S. purpurea* in the New Jersey swamps, and find that the ground-game, notably ants, are largely caught by the pitchers. Flying insects and slugs are not uncommon, and though bulk for bulk they may yield a considerable food supply for the plants, Hooker's supposition [that the pitchers are especially adapted for catching ground-game] appears correct for this species. In one specimen examined, a large nest of ants had been established in three of the older and rather dry brown leaves, just beneath the reddish green leaves that were actively catching prey."[1]

---

[1] More recently he has published observations on another species (*S. catesbæi*) from the Southern States (The History, Structure and the Distribution of *Sarracenia catesbæi*. Contrib. Bot. Lab. Univ. Pa., II, 1904, pp. 426–434).

[2] Descriptions and Natural History of Two Insects which Brave the Dangers of *Sarracenia variolaris*. Trans. Acad. Sci. St. Louis, III, 1874, pp. 235–240, 2 figs.

That these insects should actually inhabit the old leaves of a plant whose fresh leaves are so admirably adapted to their destruction, is a reflection on ant "intelligence," especially in view of the fact that some other animals have learned to turn the insect-eating habits of one of the species of *Sarracenia* to their own advantage. Meehan (*l. c.*) cites an observer who has seen birds hanging about the pitchers of *S. variolaris* and even splitting them for the sake of feeding on the entrapped insects, and Riley (*l. c.*) describes the larva of a moth which feeds on the leaves of the same *Sarracenia* and a carrion fly whose larvæ actually develop in the macerating insects at the bottom of the pitchers. The moth is *Exyra semicrocea*. "The egg is laid within the tube and the young larva covers the smooth surface with a fine gossamer-like web, generally closing up the mouth by webbing the lips together. As it increases in size it frets the leaf within, feeding on the parenchyma and leaving only the epidermis. The ochre-colored excrement falls in pellets to the bottom of the tube, where it gathers in a compact mass above the putrid remains of the insects which have been captured before the closing of the mouth. The transformations are undergone in a slight cocoon usually constructed just above the mass of excrement. There are at least two broods of the insect each year, the first larva appearing during the early part of May, the second toward the end of June."[2] The development of the fly (*Sarcophaga sarraceniæ*) is thus described by Riley: "The mother fly drops her living larvæ within the tube to the number of upward of a dozen, and these easily find their way to the bottom, where they feed on the softer parts of the macerating insects which have accumulated there. As a rule but one of the *Sarcophaga* larvæ matures, the others having fallen victims to its gluttony and superior strength. When full fed, or rather when it has appropriated all the nourishment at hand, this maggot works through the tube (by this time weakened and decayed at the base) and burrows in the ground, where it undergoes its transformations, and whence in a week or more, according to the season, the fly emerges."

---

[1] On August 29, while the manuscript of this article was being copied for the printer, Miss Delia Marble had the kindness to send me several fine specimens of *Sarracenia purpurea* from a bog near Bedford, New York. The pitchers contained no specimens of *Cremastogaster* but instead species of two other genera, namely, several dead workers of a variety of *Formica fusca* near *subænescens*, two dead females of *Dolichoderus mariæ*, which does not nest in bogs, and in one of the old and somewhat withered pitchers, a fine living colony of *D. plagiatus pustulatus* var. *inornatus*, a rare ant of which I had never before seen the nest. This colony contained numerous pupæ and winged females. A search through the insect remains in the pitchers on the same and other plants failed to reveal any traces of *inornatus* workers. During September Mr. E. Daecke sent me from Toms River, New Jersey, a small, partially dried pitcher of *S. purpurea* in which he had found a living colony of another ant, *Tapinoma sessile*. Can it be that these ants have learned to exploit the *Sarracenia* without being entrapped?

[2] More recently Mr. F. M. Jones has published an interesting paper (Pitcher-Plant Insects, Entom. News, XV, 1904, pp. 14–17, pls. iii. and iv.) on the moths that breed in the pitchers of *S. flava*. He enumerates three species (*Exyra ridingsii*, *semicrocea* and *rolandiana*). He also Eds that a solitary wasp (*Isodontia philadelphica*) builds its nest in the pitchers.

A few years ago Dr. J. B. Smith discovered another dipterous insect, a mosquito (*Wyeomyia smithii*) whose larval and pupal stages develop in the liquid of the pitchers of *S. purpurea.*[1] Mr. Daecke writes me that he has found the *Wyeomyia* larvæ near Bamber Station, New Jersey, in pitchers in which so many *Cremastogasters* had been drowned, that he "wondered how they could exist, since the water must have been laden with formic acid." According to Dr. Smith these larvæ do not need to come to the surface of the liquid to breathe, like the larvæ of *Culex*, and even lived "for nearly two weeks under a film of oil which covered the surface of their breeding jar." He also finds that this insect winters in the *Sarracenia* pitchers "in the larval stage, freezing and thawing as often as need be during that season. It pupates late in May and becomes adult a week or ten days later. Eggs are laid in the leaves singly or in small groups; fastened to the sides or floating on the surface. The summer broods mature in about a month, and there are probably three if not four series; but the broods overlap so much that the breeding is practically continuous. Late in the season the adults select the new leaves for oviposition even if they are yet dry." [2]

It is evident that if the ants had sufficient intelligence to gnaw holes in the walls of the pitchers, they could not only enter and leave these organs at will, but also visit the nectaries and perhaps secure plenty of insect food with impunity. Although *Cremastogaster* has not yet developed this ability, there is no reason to suppose that it may not do so in the course of time. I am led to entertain this possibility because Vosseler[1] has recently seen some African ants which actually accomplish a similar feat. These insects were very fond of entering the immature flowers of *Cobæa scandens* and cutting away the woolly accumulation of hairs at the base of the bell-shaped corolla in order to reach the nectaries. When Vosseler plugged the opening of the corolla with cotton, the ants gnawed holes in the base of the flower and thus attained their end in the directest manner possible.

---

[1] Ent. News, XXII, 1901, pp. 180, 254; Life History of Aëdes smithii Coq., Journ. N. Y. Ent. Soc., X, 1902, pp. 10–15; see also for a description of the larva: H. G. Dyar, Descriptions of the Larvæ of Three Mosquitoes. Journal of the N. Y. Ent. Soc., IX, 1901, pp. 177–179, pl. x, figs. 1–2.

[2] The above mentioned insects are by no means the only ones that can live in the *Sarracenia* pitchers. While examining the plants sent me by Miss Marble I found, in addition to the *Wyeomyia* two other fly larvæ that manage to thrive and develop in the digesting insect remains at the bottom of the pitchers. One of these was a *Chironomus* larva, present in considerable numbers in several of the pitchers, the other was apparently a Tipulid larva, of which only a single individual was seen.

3. MYRMICA AND THE SUN-FLOWER.

Professor T. D. A. Cockerell has recently called my attention to a third case of maladjustment in the relations of ants to plants. In the neighborhood of Boulder, Colorado, he has repeatedly seen masses of ants (*Myrmica rubra brevinodis* var.) attracted and killed by the sap that exudes from broken stems and petioles of the sun-flower (*Helianthus annuus*). This plant is very abundant in the lower ground about Boulder, and its sap, as I can testify from personal observation, becomes excessively sticky on exposure to the air, so that an ant that has once touched it with its legs or antennæ is held fast until it perishes. In this case it is difficult to see how the plant can profit by destroying the insects, for the catastrophe is purely accidental, depending on an occasional injury to the plant. A typical specimen showing a number of dead ants partially embedded in the inspissated sap, was kindly forwarded to me by Professor Cockerell and is represented in the accompanying figure. It is interesting as showing on a small scale the way in which ants and other insects became embedded in such substances as amber and copal.

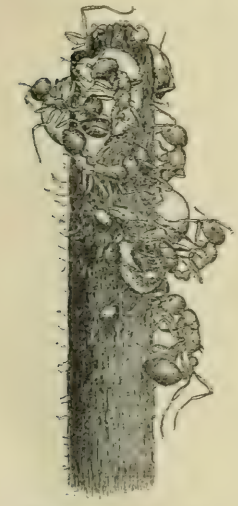


Fig. 1.— Broken twig of Sunflower, showing ants (*Myrmica brevinodis*) caught and killed by the exuding sap.

Professor Cockerell surmises that this fatal condition, in which, as in the preceding instances, the ants succumb, may be due to the meeting of two organisms originally belonging to widely separated biogeographical environments; the *Myrmica* being essentially a northern or subboreal species, while the sun-flower represents an austral element which has, during comparatively recent times, invaded the domain of the *Myrmica*. This view, which is certainly plausible in this instance, will not, however, apply to the preceding cases, for the *Polytrichum* and *Formica exsectoides* are both subboreal organisms, and the pitcher-plant and *Cremastogaster pilosa* are both of subtropical origin, and there is every reason to believe that these organisms have been associated with each other for long periods of time. It seems natural to suppose that in all the cases described in this article the havoc wrought by the plants is not sufficiently great seriously to impair the vitality of the respective species of ants. In other words, the drain of a heavy annual destruction of individuals or even colonies may be easily borne by organisms capable of reproducing so rapidly and abundantly as these insects.

---

[1] Verhinderung des Fruchtansatzes bei Cobæa durch Ameisen. Zeitschr. f. wiss. Inseckt. Biol., II, 1906, pp. 204–206.

EXPLANATION OF PLATES.

Photographs of *Formica exsectoides* mounds found near Scotch Plains, New Jersey. The dimensions of the nests are given on p. 404 under their respective numbers.

Plate LXIII. Nest No. 11, of unusually large size and still retaining the broad basal zone of sparse grass so characteristic of younger nests.

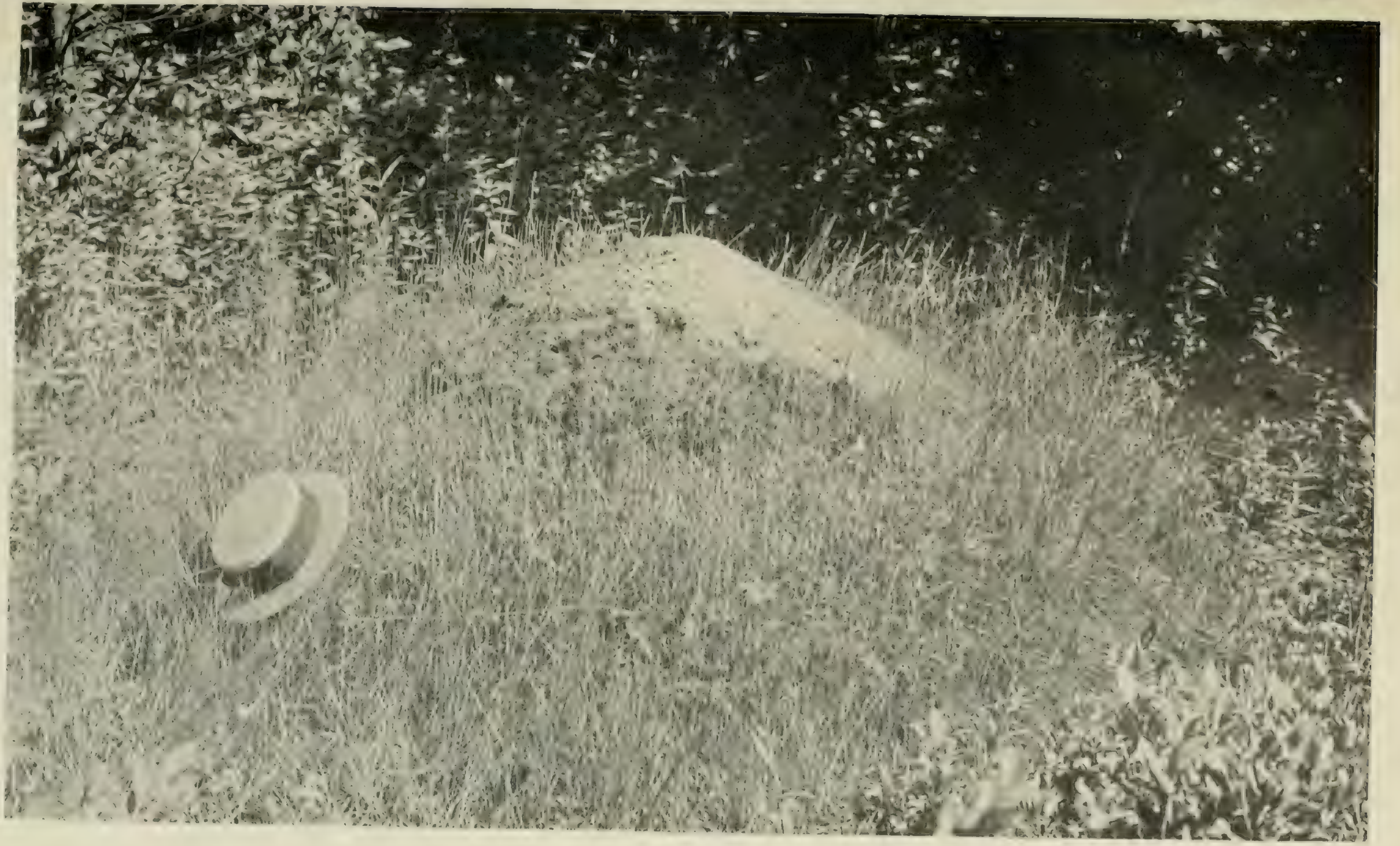
Plate LXIV. Four nests (not included in the table on p. 404) from a group of several in a clearing. These nests had been denuded of all grass by their ant inhabitants.

Plate LXV. Nest No. 7, the largest of the colony. It was surrounded by a zone of moss (*Ditrichum pallidum*) which, however, does not show in the photograph.

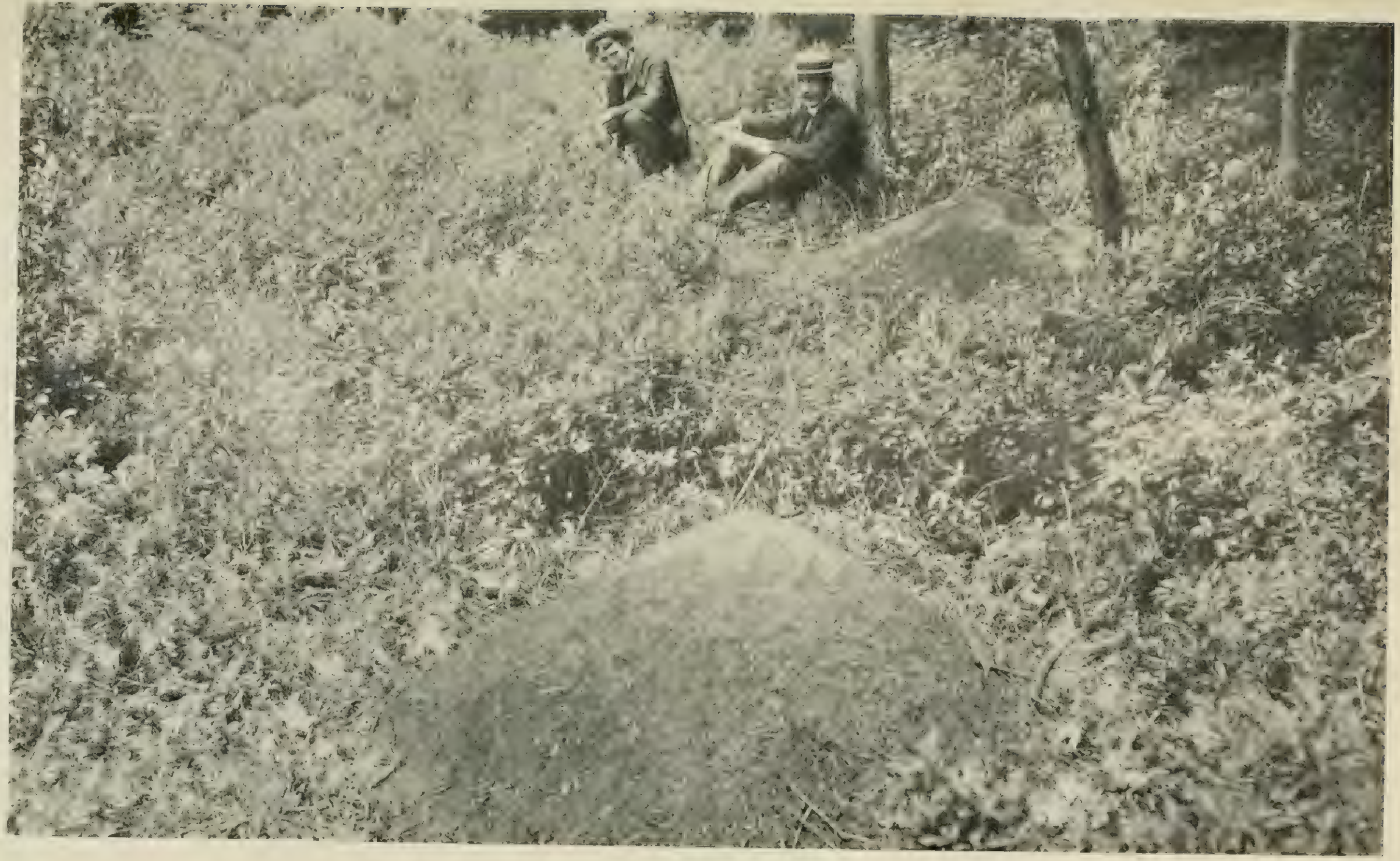
Plate LXVI. Twin nests invaded by moss (*Polytrichum commune*). The one in the foreground is No. 6 of the table on p. 404.

Plate LXVII. Nest No. 10, showing the zone of *Polytrichum* advancing and extinguishing the grass zone of an earlier stage (conf. Plate LXIII).

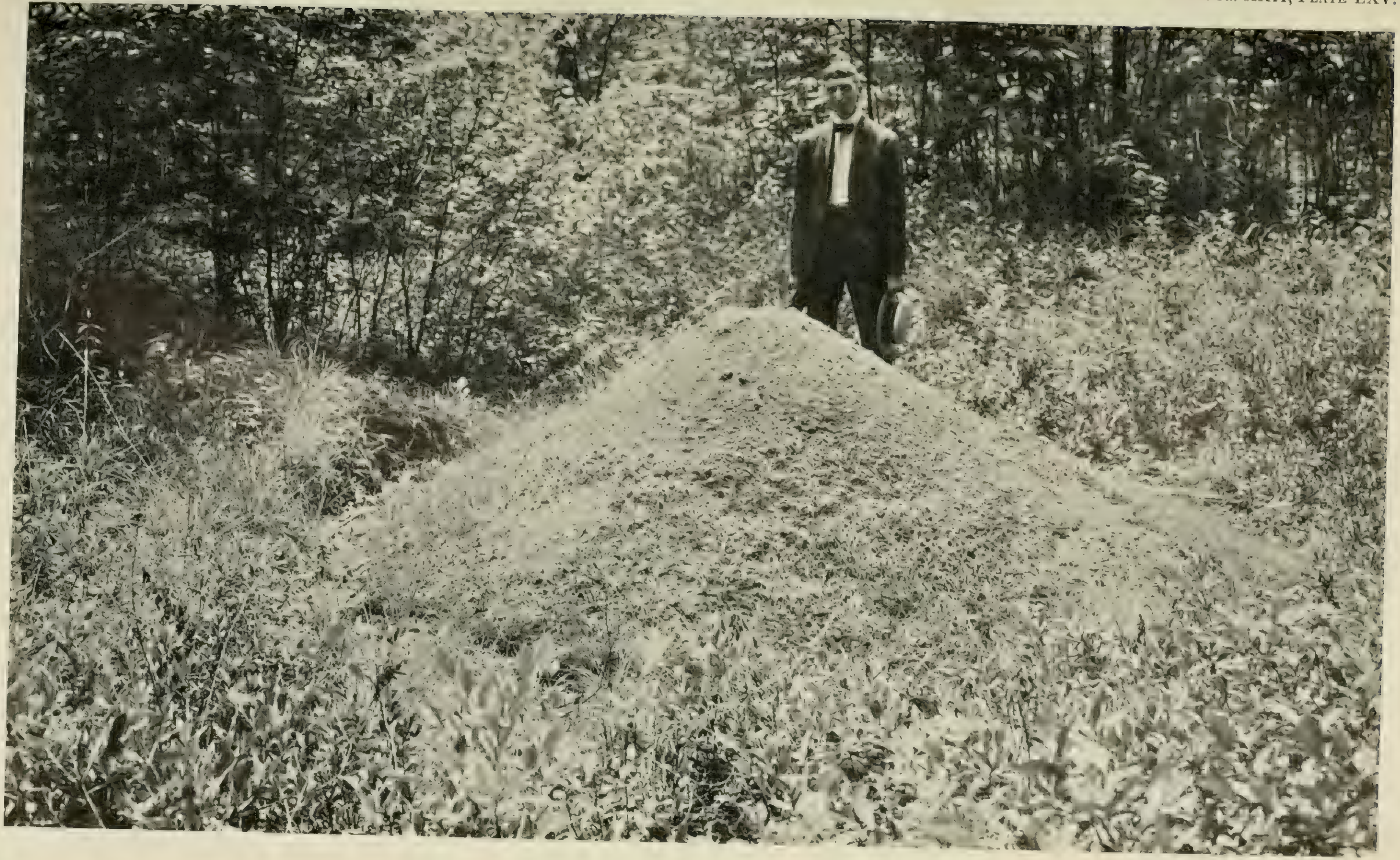
Plate LXVIII. Nest No. 8, showing the *Polytrichum* zone far advanced toward the summit, or umbilicus, which it will eventually cover.



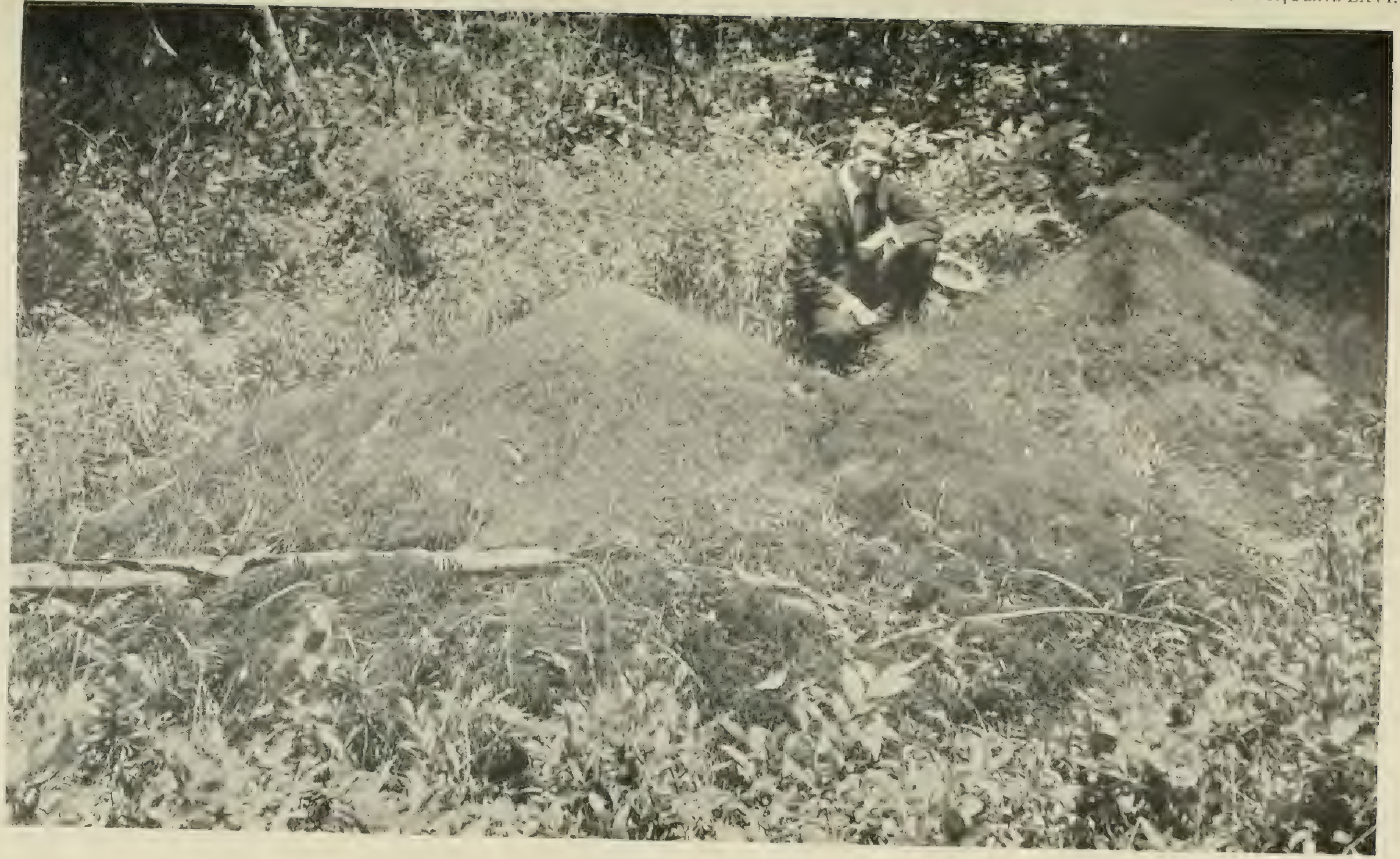
Large Nest of *Formica exsectoides* with Grass-Zone.



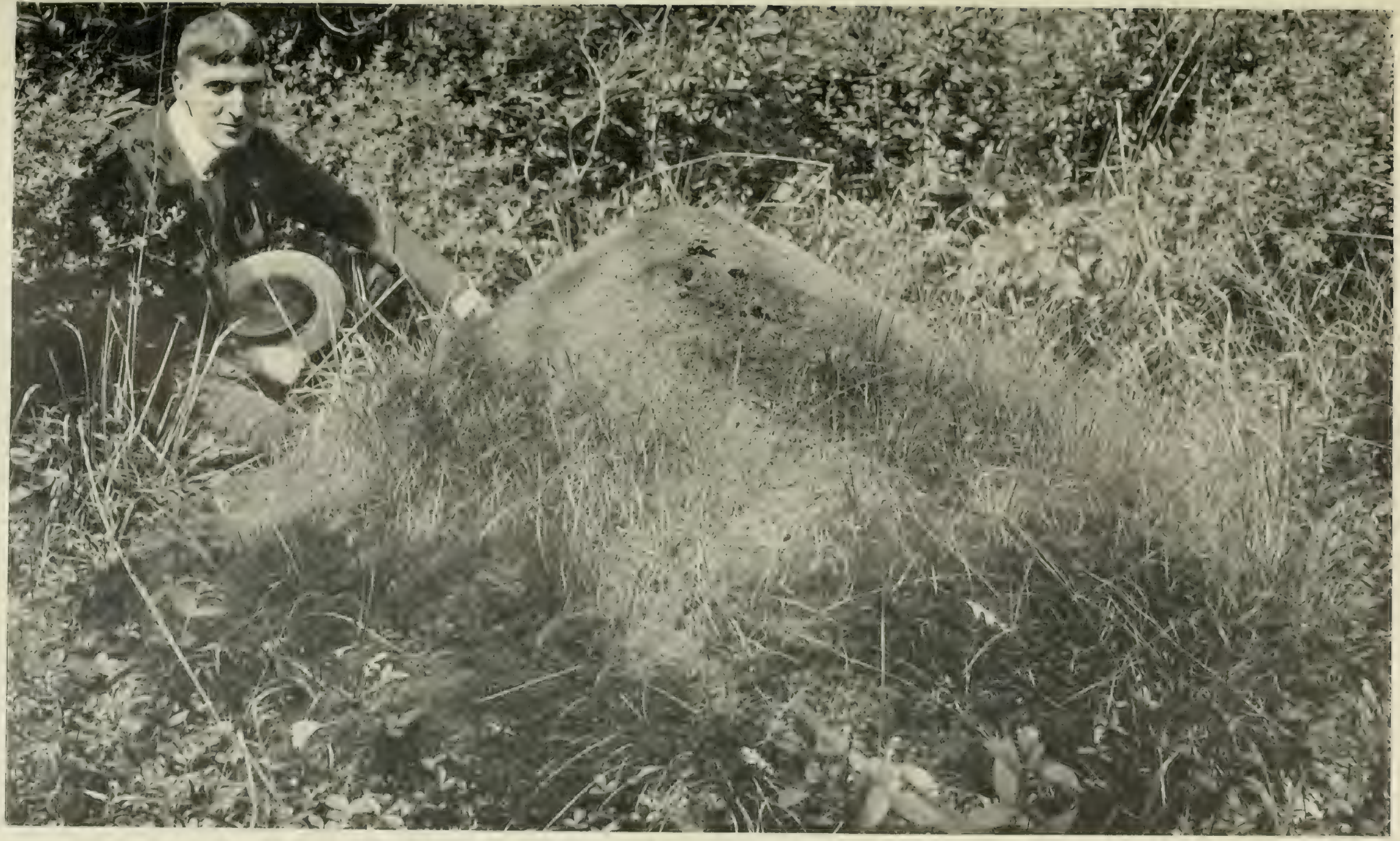
Denuded Nests of *F. exsectoides*.



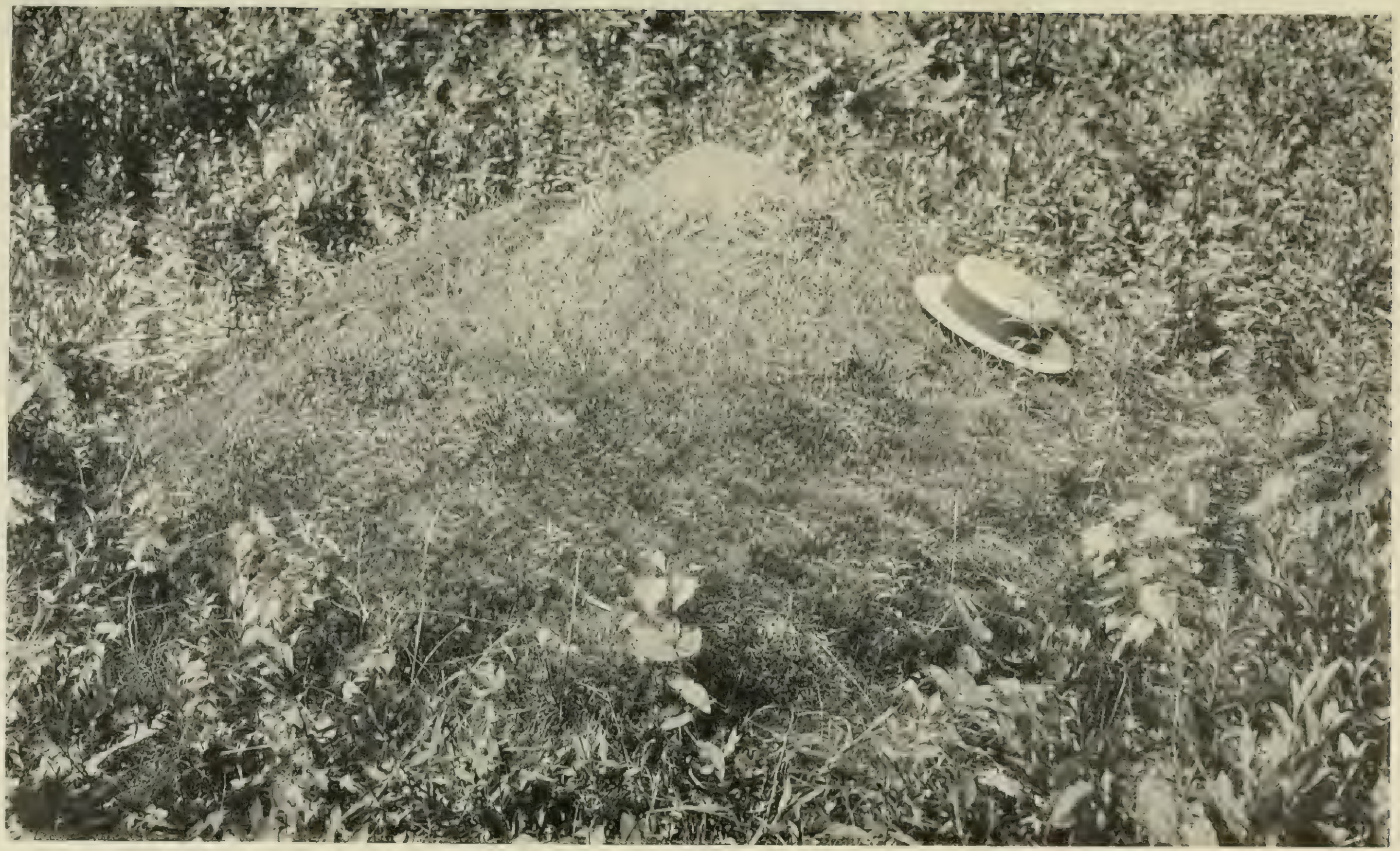
LARGE *F. exsectoides* NEST WITH ZONE OF *Ditrichum pallidum.*



TWIN NESTS OF *F. exsectoides* WITH ZONES OF *Polytrichum commune.*



NEST OF *F. exsectoides* WITH ZONES OF GRASS AND *Polytrichum*.



NEST OF *F. exsectoides* WITH ADVANCED *Polytrichum* ZONE.

59.57;99,(78.8)

Article XXV. — THE BEES OF FLORISSANT, COLORADO

By T. D. A. Cockerell.

Florissant, in Teller County, Colorado, has an altitude of a little over 8000 feet. The collection now reported on was obtained during the months of June and July, 1906, and consists of 119 identified species, of which 34 are supposed to be new, two representing new genera. This remarkably fine series is principally due to the industry of Mr. Sievert A. Rohwer (whose name is abbreviated to R. in the list); but material was also collected by my wife (W. P. C.), Dr. W. M. Wheeler and myself (C.). All the records pertain to Florissant proper, except when the contrary is indicated. Topaz Butte (or Crystal Mountain) is a mountain near Florissant, and the material from thence is mostly from an altitude near 9000 feet. Lake George is a little lower than Florissant, and while only a few miles away, is in Park County. The numerous records from "East of Lake George" are from between the lake and Florissant, but nearly all, at least, in Park County.

Only two lists of bees from such an altitude in the Rocky Mountains have been published. The first (Trans. Amer. Ent. Soc., 1893, pp. 337–340) is from Wet Mountain Valley, Colorado, which has about the same altitude as Florissant, and is nearly sixty miles almost due south of it. This is an open valley, with xerophytic features, and should have a fauna similar to that of Florissant; but unfortunately only 38 definitely determined species have been recorded, though others were collected. Of the 38, only 11 are in the Florissant list, but some of those not definitely determined are probably the same.[1] That the number of species in common is not greater is partly explained by the fact that several of the Wet Mountain Valley species are such as fly early in the year, and would be over or scarce by June; it is also probable that there are some erroneous identifications. That the Florissant list, though large, is by no means complete even for the midsummer months, is evident from the large number of species represented only by one or two specimens.

The other list — a much more important one — is from Beulah, New Mexico (Viereck, Trans. Amer. Ent. Soc., 1903, pp. 44–66).

---

[1] *Bombus ternarius* and *Anthophora bomboides* of the Wet Mountain Valley list are doubtless *B. huntii* and *A. neomexicana*. "*Habropoda* sp." is probably *Emphoropsis mucida*. *Agapostemon* sp. is doubtless *A. texanus*. The supposed *Megacilissa* is doubtless wrongly determined, and the four species of "*Cilissa*" belong to *Andrena*. *Nomia nortoni* I regard with some doubt.

Allowing for various changes and additions I have been able to make the Beulah list numbers 104 species, of which 32 were new. Beulah, in the Las Vegas Mountains, has an altitude of about 8000 feet, but it is really more boreal than Florissant, being situated in a narrow, densely wooded cañon. Its fauna and flora are strictly those of the Canadian Zone; while Florissant, open, sunny, and comparatively dry, has many austral elements.[1] The following genera are in the Beulah list, but not in that from Florissant; the number of species is given in parenthesis after each:

Triepeolus (1), *Heriades* (1), *Ashmeadiella* (2), *Coelioxys* (2). Of these, it is safe to say that three certainly must exist at Florissant, although they were not found; the fourth (*Ashmeadiella*) is an austral type, and may be expected at Florissant.

The following genera, found at Florissant, were not observed at Beulah:

Emphoropsis (1),
Dianthidium (1),
Agapostemon (2),
Titusella (1),
Alcidamea (1),
Spinoliella (1),
Calliopsis (2),
Oreopasites (1),
Ceratina (1),
Chelynia (2),
Stelis (1).

These are, in the main, characteristically austral types; it is thus apparent that Florissant possesses the typically boreal genera, and at the same time many austral ones, a combination which explains the great richness of its bee-fauna. The following genera, while occurring both at Beulah and Florissant, have no species in common: *Nomada*, *Anthidium*, *Halictoides*, *Sphecodes*. Of the genera in common, the following have more species in the Beulah list than in the Florissant one (the excess is given after each): *Bombus* (1), *Megachile* (3), *Halictoides* (1), *Panurginus* (5), Colletes (1), *Prosopis* (6). It will be seen at once that these are in the main boreal types; and it seems that Beulah, while no richer in boreal *genera* than Florissant, is markedly richer in boreal *species*. Against this, however, is an unexplained excess (9) of *Osmia* at Florissant.

It appears that there are 37 species common to the Beulah and Florissant lists; 64 at Beulah but not at Florissant; 81 at Florissant but not at Beulah. Perhaps the most characteristic species common at Beulah and absent at Florissant is *Halictus aquilæ* Ckll.

Comparing the recent with the fossil bee-fauna of Florissant, it is to be noted that of the nine fossil genera reported, three are extinct, but five of the remaining six still live at Florissant. The sixth

---

[1] See Dr. F. Ramaley, University of Colo. Studies, Vol. III, p. 179. As a characteristic austral plant common at Florissant, we may cite *Yucca glauca*.

(*Heriades*) is in the Beulah list, and doubtless will be found at Florissant.

As far as possible, the flower-visiting records are given. The principal flowers visited are the following:

Iridaceæ.

Iris missouriensis Nutt. Visited by many species. Compare 'American Naturalist,' Vol. XXXVI, p. 815, and 'Entomological News,' 1901, p. 38

Polygonaceæ.

Eriogonum umbellatum Torrey. Has an oligotropic *Perdita.*

Ranunculaceæ.

Halerpestes cymbalaria (Pursh) Greene. Visited by various species. See also 'Zoologist,' 1898, p. 79.

Cruciferæ.

Erysimum: a species with yellow flowers, probably *asperum*, but perhaps one of the recent segregates. Visited by various species.

Draba sp. Several species.

Capparidaceæ.

Peritoma (or *Cleome*) *serrulatum* (Pursh). This plant is not very abundant at Florissant, but seems well established. It is an austral type. For a long list of visitors see 'Entomological News,' 1901, p. 40.

Crassulaceæ.

Sedum stenopetalum Pursh. Flowers yellow.

Hydrangeaceæ.

Edwinia americana (T. and G.) Heller. Common, and proved a good bee-plant.

Grossulariaceæ.

Ribes longiflorum Nutt. Several species. See also 'American Naturalist,' XXXVI, 812.

Rosaceæ.

Argentinia anserina (L.) Rydb. Various species. For a long list of European visitors, see Knuth, 'Blütenbiologie,' Vol. II, part 1, p. 369.

Chamærhodos erecta (L.) Bunge, det. A. Nelson. East of Lake George; a good bee-plant, notwithstanding the smallness of the flowers. The plant goes north to Alaska.

Dasiphora fruticosa (L.) Rydb. Several species. For a good list of visitors in Europe, see Knuth, 'Blütenbiologie,' Vol. II, part 1, p. 374.

Leguminosæ.

Aragallus sp. or spp. of the *lambertii* group.

Linaceæ.

Linum lewisii Pursh. Several species on this magnificent blue flax.

Malvaceæ.

Sidalcea neomexicana A. Gray. A species of a western and southwestern genus.

Asclepiadaceæ.

Asclepias speciosa Torrey. Not many bees.

Polemoniaceæ.

Polemonium sp. The common species at Florissant, to which all our records refer, is the large one formerly referred to the Old World *P. cæruleum*, which it certainly resembles very much. Whether it is the more recent segregate *P. occidentale* Greene, I cannot positively state.

Hydrophyllaceæ.

Phacelia alba Rydberg. Has an oligotropic *Perdita*. *P. congesta* Hook., in New Mexico, also has a *Perdita*, but it is an entirely different species (*cf.* Amer. Nat., XXXVI, 811).

Boraginaceæ.

Lappula floribunda (Lehm.) Greene. A beautiful blue-flowered species, like a sort of gigantic forget-me-not.

Scrophulariaceæ.

Scrophularia occidentalis (Rydb.) Bickn. Especially visited by *Prosopis*.

Pentstemon secundiflorus Benth. This splendid species occurred in large patches, and was much visited by bees.

Synthyris (or *Besseya*) *plantaginea* Benth. Unexpectedly, this was quite freely visited by certain species.

Pedicularis crenulata Benth., det. A. Nelson. Common in marshy places, the flowers deep pink.

Compositæ.

Hymenoxys ligulæflora (A. Nelson). I have treated this (Bull. Torr. Bot. Club, 1904, p. 474) as a subspecies of *H. richardsoni*, but after seeing it alive, I am willing to provisionally regard it as a species, including in it the *H. macrantha* (A. Nels.) Rydb. It is very common at Florissant, and is the only *Hymenoxys* I found there. Rydberg, in his newly published 'Flora of Colorado', treats *macrantha* as a species, and leaves *ligulæflora* out of the list. I feel assured, however, that they are not separable, and *ligulæflora* is the older name. I still incline to the view that *ligulæflora*, *pumila*, etc., are completely confluent with *richardsoni* to the northward, but the case should be established with more material and particularly studies in the field. The species reported and figured in a recent (1906) 'Bulletin' of the Colorado Experiment Station as *H. floribunda* is evidently *ligulæflora*.

The following abbreviations are used in the list: s. m. = submarginal cell. b. n. = basal nervure. r. n. = recurrent nervure. t. c. = transverso-cubital nervure. t. m. = transverso-medial nervure. fls. = at flowers of.

1. **Prosopis basalis** *Smith*. 1 ♂, Topaz Butte, June 17 (R.).

2. **Prosopis antennata** *Cress.* 2 ♂, July 11 and 19, the latter at flowers of *Lappula floribunda* (C.).

3. **Prosopis tridentula** *Ckll.* 1 ♂, July 19 (C.).

4. **Prosopis divergens** *Ckll.* 1 ♂, July 10 (R.).

5. **Prosopis varifrons** *Cress.* 17 ♀, July 12 to 25. These run to *varifrons* in my table in 'Entomologist,' Oct. 1898, but seem rather large. It is probable that the insects recorded at various times as *varifrons* include more than one species, but I cannot point to any satisfactory means of separation, in the absence of the males. The Florissant specimens visited various flowers: *Scrophularia* (C., R.), *Lappula* (R.), *Cleome serulata* (C.), *Linum lewisii* (C.), *Dasiphora fruticosa* (C.), and *Pentstemon secundiflorus* (C). Most were taken on the *Scrophularia* and *Pentstemon*.

6. **Prosopis pygmæa** *Cress.* 1 ♀, July 11 (C.). It represents a variety (or closely allied species) with the lateral face-marks reduced to a small spot on each side.

7. **Prosopis tuertonis**, sp. nov.

♀. Length about 5 mm. Black; head and thorax densely punctured; light markings cream-color or slightly yellower; clypeus dull, with shallow punctures; *lateral face-marks narrow*, broadest opposite upper part of clypeus, slightly indented below antennæ, the upper end slightly divergent from the eye; flagellum ferruginous beneath; mesothorax densely and strongly punctured; small spot on tegulæ, large spot on tubercles, and broken band on hind border of prothorax pale yellow; pleura rugoso-punctate; area of metathorax with a strong subcancellate sculpture; wings hyaline, beautifully iridescent, stigma and nervures very dark brown; first r.n. entering first s.m. just before its apex; b.n. falling a little short of t.m.; abdomen shining, *first segment very delicately punctate;* knees yellow, the yellow extending a little way down anterior and hind tibiæ.

Type from Tuerto Mountain, near Santa Fé, New Mexico, 8550 feet, at flowers of a Crucifer, Aug. 7 (*Cockerell*). Also from Florissant. 1. ♀, July 12, fls. *Lappula* (R.). This is the species mentioned, without a name, in 'Entomologist,' 1898, p. 217.

8. **Colletes nigrifrons** *Titus.* 7 ♀, July 9 to 23. At flowers of *Linum lewisii* (C.), *Ranunculus* (R.), *Argentinia* (W. P. C.), and *Dasiphora* (*R.*)

9. **Colletes kincaidii** *Ckll.* 2 ♂, July 9 and 11, one at fls. *Polemonium* (R.).

10. **Colletes oromontis** *Vier.* 3 ♀, June 21 and 22, two at *Mertensia*, one at *Senecio* (R.).

11. **Colletes phaceliæ** *Ckll.* 1 ♀, June 18 (R.).

12. **Colletes salicicola geranii** *Ckll.* 2 ♂, June 16, fls. *Synthyris plantaginea* (C.), June 22, fls. *Senecio* (R.).

13. **Colletes sieverti**, sp. nov.

♂. Length about 8½ mm. Black, with abundant dull white pubescence, which has a faint yellowish tint on the head and thorax above; head broad, eyes converging below; face densely covered with very long hair; *labrum with a small but very distinct median pit;* mandibles strongly bidentate; *malar space broader than long, but not greatly so; antennæ long*, the joints of the flagellum longer than broad, wholly dark; mesothorax shining, but very strongly and rather closely punctured; scutellum with large strong punctures, becoming very sparse anteriorly; *thorax above wholly without dark hair; area of metathorax with a strong transverse ridge*, above which are about eight quadrangular pits; below the ridge the area is shining, the upper part with a longitudinal ridge; lateral faces dullish, roughened; tegulæ dull testaceous; wings hyaline, nervures and stigma very dark reddish brown; second s.m. very broad, receiving r.n. about its middle; legs normal, the tarsi black; spurs yellowish white; abdomen shining, very strongly and quite closely punctured, all the segments with entire white hair-bands; first segment and middle of second with much erect white hair.

Type from Florissant, Colo., July 19, at flowers of *Geranium* (R.). In my table in *Psyche*, Oct. 1905, this runs to *C. spurcus* Vier., but it differs from that species in being somewhat larger, the first r. n. not joining second s. m. before the middle, and the total absence of dark hairs on the abdomen. In Robertson's table it runs nearest to *culophi*, but it is not that. It has a strong superficial resemblance to the European *C. hylæiformis* Ev., but that insect has the abdomen very much more coarsely punctured. The following table separates it from several western males which show a very close superficial resemblance:

Thorax above with some dark hair . . . . *skinneri* Vier.
Thorax above without dark hair 1
1. Hair of face perfectly white, contrasting with the yellowish of the mesothorax; area of metathorax, below the transverse keel, obliquely plicate at sides . . . . *gaudialis* Ckll.
Hair of face colored like that of mesothorax 2
2. Face narrower below; hair of face and thorax above ochreous . . . . *ciliata* Path.
Face broader below; hair of face and thorax above yellowish-white *sieverti* Ckll.

14. **Colletes florissantia**, sp. nov.

♂. Length 8 mm. or slightly more. Black, with abundant dull white hair, faintly yellowish on head and thorax above, but shining and pure white over clypeus; head broad, eyes converging below; mandibles reddened apically; labrum shining, with no distinct pit; *malar space very short*, at least twice as broad as long; antennæ only moderately long, *the joints of flagellum not much longer than broad;* flagellum faintly brownish beneath; mesothorax shining, with small punctures, rather dense at sides, but lacking entirely in middle; scutellum well punctured; area of metathorax coarsely sculptured, the transverse keel scarcely evident, the lower part of the area covered with large wrinkles, except the lower end, which is occupied by a large shining hollow; lateral faces coarsely roughened; tegulæ dark, wings hyaline, nervures and stigma dark; second s.m. twice as broad below as above, *receiving the first r.n. a little before its middle; no dark hair on thorax above;* legs normal, tarsi black; abdomen shining, the hind margins of the segments with dense white hair-bands; first segment with small but distinct punctures, second more closely punctured, third still more closely, the following segments becoming finely rugoso-punctate; hind margins of ventral segments finely ciliate rather than fasciate.

Type from Florissant, June 22 (R.). In my table it runs to *C. paniscus*, in Robertson's near to *C. willistoni*. It differs from *paniscus* by having the third antennal joint shorter than the fourth, the first r. n. entering second s. m. before the middle, and especially the sculpture of abdomen. It was taken on the same day as a ♀ *oromontis*, and I thought it might be the unknown male of that species. However, the sculpture of the metathorax and abdomen seem too different, and I think it much more likely that *C. paniscus* is the true ♂ of *oromontis*, in which case the latter name would fall, *paniscus* having priority of place. The types of *paniscus* and *oromontis* were taken at Beulah, N. M., on the same day.

15. **Colletes polemonii**, sp. nov.

♂. Length 7½–8 mm. Black, shining, with long white hair, dullish but not yellow on thorax above, shining and very white over clypeus; labrum shining, the pit rudimentary; malar space extremely short; flagellum dark brownish beneath, the joints not greatly longer than broad; mesothorax finely punctured at sides, but smooth and impunctate in the middle; metathorax much like that of *florissantia*, but the shining hollow extends further up; tegulæ piceous; wings hyaline, nervures and stigma very dark reddish-brown; second s.m. broad, but twice as broad below as above, receiving the first r.n., a little before its middle; legs normal; tarsi black, spurs piceous; abdomen shining, finely punctured, punctures weaker and less dense on the first segment than on the second; hind margins of segments with dense white hair-bands, that on first weak in the middle; ventral segments finely ciliate.

Type from Florissant, June 27, fls. *Polemonium* (R.). Also July 11, fls. *Ranunculus* (R.). In my table it runs to *C. gypsicolens*, in Robertson's near to *C. willistoni*. From *gypsicolens* it is known at once by the short antennæ; from *willistoni*, which I have not seen, it appears to differ in the metathorax. *C. willistoni* is said by Robertson to collect its pollen from *Physalis;* it is known only from Illinois and Nebraska. From *C. florissantia*, the present species is readily known by its smaller size, and the lack of a yellow tint in the hair of the thorax above.

16. **Sphecodes pecosensis** *Ckll.* 1 ♀, June 29, fls. *Edwinia* (R.).

17. **Sphecodes eustictus** *Ckll.* 6 ♀. Previously known only by the unique type, from Prospect Lake, Colorado Springs. The mandibles vary, being distinctly dentate, or merely with an inner angle. Topaz Butte, June 17 (R.); Lake George, July 5 and 18, one by a nest of *Spinoliella scitula* (W. P. C.); Florissant, June 15–July 24, fls. *Argentinia* (R.).

18. **Sphecodes sulcatulus,** sp. nov.

♀. Length about 6½ mm. Head and thorax black, shining; head broad, facial quadrangle distinctly broader than long; clypeus with a rather dense but somewhat irregular punctation; mandibles dentate, the apical part reddened; labrum shining, with a row of feeble pits; cheeks striate; front with rather sparse punctures; flagellum brown beneath; vertex not tuberculate, transversely wrinkled behind the ocelli; mesothorax very shiny, with sparse but distinct punctures, and a prominent median sulcus; pleura coarsely roughened; area of metathorax semilunar, with irregular radiating wrinkles; posterior face malleate; tegulæ with a reddish spot and pallid margin; wings reddish, the nervures and stigma dark reddish-brown; first r.n. joining second s.m. very near its end; legs black, the tarsi and anterior tibiæ in front dark reddish; abdomen of the usual shape, extremely shiny, hardly punctured; the first three segments brilliant chestnut red, the others black, except that the fourth is red at the sides of the base; no depression between first and second segments in lateral view.

Type from Florissant, July 1 (R.). In Robertson's table it runs to *S. minor*, but is quite different by the sulcate mesothorax and black apex of abdomen. The following table separates it from two rather similar western species:

Apex of abdomen not darkened; area of metathorax coarsely irregularly reticulated . . . . *sophiæ* Ckll.
Apex of abdomen more or less darkened 1
1. Abdomen broad, the first segment with a short longitudinal sulcus on the disc; area of metathorax plicatulate . . *sulcatulus* Ckll
Abdomen narrower, the first segment wholly without such a sulcus; area of metathorax coarsely irregularly wrinkled . . *washingtoni* Ckll

19. **Agapostemon texanus** *Cress.* 4 ♀. Eyes in life pea green. Sculpture of metathorax remarkably variable. June 15–July 18, fls. *Senecio* and *Polemonium* (R.).

20. **Agapostemon coloradensis** *Crawf.* 2 ♀, June 18 and 21, both fls. *Senecio* (R.). Also occurs at Boulder; fls. *Carduus.*

21. **Halictus sisymbrii** *Ckll.* Very abundant. One ♂, east of Lake George, June 18 (R.). The following records relate to females: east of Lake George, June 18, several, one at fls. *Halerpestes cymbalaria* (R.). Florissant, June 15–July 22, fls. *Lappula floribunda* (*C.*) *Linum lewisii* (C.), *Polemonium*, many (R., C.), *Edwinia* (R.), and *Epilobium* (R.). Also found at Boulder.

22. **Halictus trizonatus** *Cress.* 6 ♀. This is the western species usually referred to *coriaceus* Smith; Mr. Crawford tells me that it is distinct from *coriaceus*, being easily separated in the male. Mr. Crawford has not seen the real *coriaceus* from further west than Michigan and Illinois. June 15--July 22; fls. *Polemonium*, three (C.), *Edwinia* (R.), and *Scrophularia* (R.).

23. **Halictus lerouxii** *Lep.* 1 ♀. Rather small, bands of abdomen very white. June 16, fls. *Synthyris plantaginea* (C.).

24. **Halictus armaticeps** *Cress.* 1 ♀. Rather small, with large head. July 1, fls. *Senecio* (R.). I took a ♂ at Colorado Springs, June 20.

25. **Halictus cooleyi** *Crawf.* 5 ♀, July 18–25; fls. *Crepis runcinata*, two (R.), *Pentstemon* (R.), *Geranium* (R.), and *Scrophularia* (C.).

26. **Halictus aberrans** *Crawf.* 5 ♀. June 20–July 20; fls. *Geranium*, two (R.), *Senecio* (R.), *Linum* (C.), and *Sidalcea neomexicana* (R.). Also two males, presumed to belong here, June 16, fls. *Iris missouriensis*, and E. of Lake George, June 18, fls. *Senecio*. Mr. Crawford writes that *H. galpinsiæ* and *aberrans*, so similar in the ♀, are widely different in the ♂.

27. **Halictus (Evylæus) synthyridis**, sp. nov.

♀. Length about 6½ mm. Entirely black, with rather scanty dull white pubescence, the abdomen not banded; head rather narrow, the clypeus produced, with large punctures; front very minutely and closely punctured; flagellum obscure brownish beneath; mesothorax shining, with sparse minute but distinct punctures; punctures on scutellum still sparser; posterior face of metathorax distinct, but sharp lateral margin failing on upper third; area semilunar, concave, very delicately sculptured with raised lines, the margin obtuse and shining; tegulæ reddish, not punctured; wings slightly dusky, very iridescent, stigma and nervures dull testaceous; second s.m. large; legs black, small joints of tarsi becoming reddish; an orange brush at end of first joint of hind tarsi; hind spur pectinate with about three spines; abdomen rather broad, with sericeous surface showing vague purplish tints; first segment except apically smooth and shining; hair of abdomen thin, rather long and white.

♂. Slender, black; antennæ very long, the flagellum dull yellowish-brown beneath; clypeus with or without a small apical pale yellowish band; legs dark.

Females June 16–July 9; the type June 16, fls. *Synthyris plantaginea* (C.); one from the same place at the same time, fls. *Iris missouriensis* (C.). One, June 17, from Topaz Butte (R.).

Males July 1–22; fls. *Polemonium* (C., R.) and *Crepis runcinata* (R).

In Robertson's table (Canad. Entom., Sept. 1902) the ♀ runs to *pectoralis*, which is not especially allied. The ♂, runs to 3, but has not the metathorax of *foxii*, nor the subbilobed scutellum and whitish tarsi of *arcuatus* and *truncatus*. From *H. dasiphoræ* Ckll., the new species is easily known by the color of the stigma, and the very shiny anterior part of scutellum and posterior middle of mesothorax. *H. dasiphoræ* also has a narrower, distinctly pruinose abdomen. The male *synthyridis* is very like that which I have presumed to belong to *H. angustior* Ckll., but is smaller, with the area of metathorax conspicuously shorter.

28. **Halictus** (**Chloralictus**) **scrophulariæ**, sp. nov.

. Length 5–5½ mm. Head and thorax green, with rather abundant pubescence, white on face, cheeks, and pleura, slightly yellowish on head and thorax above; head normal, face bluish-green, clypeus and supraclypeal area with a brassy or even slightly coppery tint, the anterior margin of clypeus broadly black, ciliate beneath with golden hairs; mandibles reddish except at base. front minutely and densely punctured; flagellum ferruginous beneath except at base; mesothorax and scutellum brassy-green, metathorax darker, pleura dark bluish-green; mesothorax shining, with a sericeous surface, the punctures very minute, the median groove distinct; metathorax with posterior face distinctly margined, the area semilunar, rugulose, without conspicuous plicæ and without a sharp margin; tegulæ shining reddish, not punctured; wings hyaline, splendidly iridescent, stigma and nervures amber-color; stigma large; first s. m. about equal to second and third combined; first r. n. joining second s. m. at apex; second r. n. and third t. c. weakened; legs black, the knees more or less and the tarsi (except for some blackish clouds) ferruginous; abdomen translucent orange-amber, a large black spot on each side of first segment, a small one on each side of base of third, and a smaller one on fourth; abdomen with delicate pruinose pubescence, but no hair-bands; hind spur with a few small teeth. The specimen from *Dasiphora* is somewhat smaller, and the abdomen has a transverse blackish line near the hind margins of the first three segments.

Type from Florissant, July 25, fls. *Scrophularia* (C.). Also July 16, fls. *Dasiphora fruticosa* (C.).

The following table separates this species from several which resemble it:

Metathorax dark, with a bluish-green tint, the area very feebly sculptured; tegulæ not brightly colored . . . *scrophulariæ* Ckll.

Metathorax yellowish-green, the area with a rather strong plicate sculpture basally; tegulæ bright apricot-color . . . . *pictus* Crawf.

Metathorax with the area roughened with minute wrinkles . . . 1

1. Abdomen rather broad, the apical part more or less infuscated *mesillensis* Ckll.

Abdomen narrow, the apical part not infuscated; size smaller than in *H. scrophulariæ* . . . . *clematisellus* Ckll.

The second s. m. is much more narrowed above in *clematisellus* than in *scrophulariæ*. Seen with a compound microscope, the front of *scrophulariæ* is covered with minute, dense, contiguous punctures; the punctures of the mesothorax are hardly so strong as in *clematisellus*. The sculpture of the second abdominal segment consists of fine transverse lineolation, with sparse punctures on the basal half. The pruinose pubescence of the fourth abdominal segment is conspicuous, whereas in *clematisellus* it is very thin and hardly noticeable.

29. **Halictus ruidosensis** *Ckll.* 13 ♀, Topaz Butte, June 17 (R.). Florissant, June 18–July 25; fls. *Edwinia* (R.), *Polemonium* (C.), *Linum lewisii* (C.), *Aragallus* (R.), *Scrophularia* (C., R.), *Carduus* (R.), and *Geranium* (R.). Also at Colorado Springs, June 20 (C.).

30. **Halictus pruinosiformis** *Crawf.* 2 ♀, July 12 and 18, fls. *Polemonium* (R.).

31. **Halictus veganus** *Ckll.* 5 ♀, June 14–21; fls. *Draba*, two (R.), *Senecio* (R.), and small white flowered *Lappula* (W. P. C.). One was at Fossil Stump Hill.

32. **Halictus** (**Chloralictus**) sp. 1 ♂. Head and thorax dark shining green; abdomen piceous; clypeus without yellow; legs without yellow. July 16, fls. *Dasiphora fruticosa* (C.).

Andrena *Fabricius.*

In order to facilitate identification, I give a table of the females.

Abdomen largely red . . . . . . *prunorum gillettei* Ckll.

Abdomen not red 1

1. Area of metathorax very coarsely sculptured and distinctly margined; punctures of mesothorax extremely large and strong . *cyanophila* Ckll.
Area not so 2
2. Abdomen black without bands, the hair beyond the first segment all black; large species 3
Abdomen with at least some pale hair beyond first segment; species mostly smaller 4
3. Hair of thorax above bright ferruginous; hair of face black *micranthophila* Ckll.
Hair of thorax above ochreous; hair of face not black *vicina argentiniæ* Ckll.
4. Hair of hind tibiæ black or dark chocolate color 5
Hair of hind tibiæ light (largely dark in *runcinatæ*, then mesothorax with much black hair) 7
5. Large species; abdomen very hairy, hair of upper part of cheeks black . . . . *ribesina* Ckll.
Medium sized species; abdomen not very or not hairy 6
6. Clypeus little punctured . . . . *topazana* Ckll.
Clypeus well punctured. . . . . *birtwelli* Ckll.
7. First r.n. joins second s.m. very near its end; hair-bands of abdomen thin, the hairs long 8
First r.n. joins second s.m. at or near middle; mesothorax without black hair 9
8. Mesothorax with much black hair . . . . . . *runcinatæ* Ckll.
Mesothorax without black hair . . . . . . *lewisii* Ckll.
9. Facial foveæ, seen from above, chocolate color; wings greyish; stigma brown . . . . *atala* Viereck
Differs from the last by the reddened wings, ferruginous stigma, etc. *fragiliformis* Ckll.
Facial foveæ, seen from above, light 10
10. Abdominal bands very feeble; facial foveæ narrow . *synthyridis* Ckll.
Abdominal bands very distinct 11
11. Wings darker; hair of thorax above reddish . . . *medionitens* Ckll.
Wings not so dark; hair of thorax above not reddish . *sieverti* Ckll.

33. **Andrena prunorum gillettei** *Ckll.* 2 ♂, 2 ♀. Both sexes fls. *Edwinia*, June 29 (R.). East of Lake George, June 18, ♀ fls. *Erysimum* (W. P. C.), ♂ fls. *Halerpestes cymbalaria* (R.).

34. **Andrena birtwelli** *Ckll.* 2 ♀, July 14 and 19 (C.).

35. **Andrena atala** *Viereck.* 16 ♀, 3 ♂, July 10–18, fls. *Polemonium* (C., R.). A male was taken as early as June 27 (R.). Described from two females collected at Beulah, N. M.; I have two other females, taken at Beulah on the same day, and also a male from that locality. The male has the hair at the sides of the face black; the antennæ long and dark. In Robertson's table it appears to run near to *A. nasonii*, but it is not that species.

36. **Andrena medionitens** *Ckll.* 7 ♀, Topaz Butte, June 17 (R.);

six from east of Lake George, June 18 (R., C., W. P. C.); fls. *Euphorbia* and *Chamærhodos erecta.*

37. **Andrena cyanophila**, sp. nov.

♀. Length about 9½ mm. Black; with rather coarse pubescence, dull white on pleura and cheeks, yellowish-white on face, ochreous on thorax above; facial quadrangle about square; clypeus shining, with very dense large punctures and a median smooth line; process of labrum rather broad, truncate; front coarsely roughened; sides of vertex with very large punctures, giving way to minute ones on cheeks; facial foveæ seen from above cream-colored, rather broad, occupying more than half the distance between eye and antennæ, below narrowing and ending a little below level of antennæ, with no noticeable space between them and the eyes; apical part of flagellum brown beneath; third antennal joint hardly as long as 4 + 5; mesothorax and scutellum shining, with exceedingly large punctures; area of metathorax well-defined, covered by strong ridges, the adjacent sides of metathorax dull and rough; tegulæ red-brown; wings dusky, rather red; stigma and nervures dark ferruginous; first r.n. joining second s.m. a little beyond middle; abdomen broad, strongly punctured, punctures on first segment sparse; second segment in middle depressed nearly or quite three fourths; no continuous hair-bands, but patches of white hair at sides of segments; fimbria pale golden; legs black, small joints of tarsi dark reddish, basal joint of middle tarsi broadened; scopa of hind tibiæ white, fuscous above at base; hair on inner side of basal joint of hind tarsi pale sooty.

Type from Florissant, July. The series contains a ♀ taken July 11 (C.), and three July 12 (R.); fls. *Polemonium;* one from *Pentstemon.* A male *Trachandrena* from Topaz Butte, June 17 (R.), is closely allied, but probably belongs to a different species.

A. cyanophila is exceedingly close to *A. salicifloris*, but differs by the more strongly sculptured metathorax and the color of hair on hind tarsi within. The color of the hair of thorax above is the same.

In Bruner's table it seems to run near *A. radiatula;* it differs by the color of the fimbria, etc. In Robertson's table (Tr. Amer. Ent. Soc., XXVIII, p. 189) it runs to 9, and comes in thus:

Abdomen with margins of segments pale testaceous; enclosure ridged . . . *claytoniæ*
Abdomen without fasciæ, black.
  Enclosure ridged . . . . *cyanophila*
  Enclosure without sharp ridges . . . . *cratægi*

The punctures of the thorax are very much larger in *cyanophila* than in *cratægi.*

In Viereck's table of northwestern species (Canad. Entom., 1904, p. 159) our insect runs to 10, and comes in thus:

Pubescence white; stigma black . . . . . . *semipunctata*
Pubescence ochreous.
  Stigma pale . . . . *striatifrons*
  Stigma dark reddish . . . . *cyanophila*

A. striatifrons is much larger than *cyanophila*, and has no smooth line on clypeus.

A. cyanophila shows much resemblance to *A. multiplicata*, but differs thus:

A. multiplicata.	*A. cyanophila.*
Hair on inner side of basal joint of hind tarsi pale ochraceous.	Hair (etc.) pale sooty.
Sculpture of metathorax throughout coarser; sides more coarsely rugose, area with coarser plications.	
Pubescence of facial foveæ grayish-white.	Pubescence (etc.) tawny.
Hair of thorax above very pale cinereous.	Hair (etc.) pale fulvous.
Clypeus with no smooth median line.	Clypeus with a very distinct median line.

38. **Andrena vicina argentiniæ**, subsp. nov.

♀. Similar to *vicina*; area of metathorax the same; but pleura usually with black or partly black hair (in one specimen it is all pale); clypeus more strongly and closely punctured; process of labrum very broadly rounded; hair of cheeks largely black; last joint of maxillary palpi longer. Compared with *A. carlini*, the area of metathorax forms a broader angle behind; the clypeus is more closely punctured, with the median ridge much less prominent.

♂. More robust than that of *carlini;* hair on inner side of basal joint of hind tarsi black; hind tibiæ with much black hair on inner side.

Type (♀) from Florissant, June 15; fls. *Argentinia* (R.); also two from east of Lake George, June 18, fls. *Senecio* (R.). Four males are from east of Lake George, June 18 (R., C.), fls. *Senecio* and *Geranium*.

39. **Andrena micranthophila**, sp. nov.

♀. Length nearly 12 mm.; black, with the long pubescence all black except that on mesothorax, scutellum, and tubercles, which is bright ferruginous, and on the upper middle of first abdominal segment, where there are some ferruginous hairs, and a tuft containing some reddish hairs on each side of antennæ, not very conspicuous; head normal, facial quadrangle much broader than long; black hair of face and cheeks long, not thick enough to conceal surface of face; clypeus shining, with close, rather ill-defined punctures, and a not very distinct median ridge; process of labrum narrow and emarginate; third antennal joint about as long as 4 + 5; flagellum dark, very faintly brownish beneath; pleura densely rugosopunctate, mesothorax about the same, with a very distinct median smooth line on its anterior half; metathorax rough and dull, the area a nearly equilateral triangle, with the corners attenuated, defined by a raised line and sculptured with irregular wrinkles; tegulæ dark, the margins reddish; wings dusky reddish; stigma and nervures dull reddish-brown, not very dark; first r.n. joining second s.m. beyond the middle; legs black, with coarse black hair; abdomen smooth and shining, with only hair-punctures; not in the least banded; fimbria black. Second abdominal segment in middle depressed about one-third; facial foveae dark, short and narrow, not separated from eye, and reaching very little below level of antennæ.

♂. Similar to ♀; occiput with fulvous hair; flagellum dull brown beneath; face without light markings.

Type from east of Lake George, June 18, fls. *Chamærhodos erecta* (W. P. C.); also three males at same time and place (W. P. C., C., R.), two at fls. *Senecio.*

Runs in Robertson's table to *carlini*, and in Viereck's table of northwestern species apparently to *pluvialis*, but it is quite different from these. Superficially, it is exactly like *berberidis* (Ckll.), but it differs at once by the sculpture of the clypeus. It is close to *A. merriami* Ckll., but differs in color of stigma, sculpture of clypeus and of area, and color of thoracic pubescence. It is easily known from *milwaukeensis* Graenicher, by the absence of conspicuous light hair at base of abdomen and denser punctures of clypeus. It is much too small for *perimelas*, and otherwise different; smaller than *lupinorum* and distinct by color of hair of face, etc.; easily known from *nivalis* by the black hair of pleura and face.

40. **Andrena ribesina**, sp. nov.

♀. Length nearly 12 mm.; black, the small joints of the tarsi dark ferruginous; hair of head and thorax abundant and rather long, pale ochreous dorsally, dull white on face and lower part of cheeks and pleura, black on upper part of cheeks, vertex (but not occiput), and more or less just beneath and behind wings; facial quadrangle broader than long; clypeus with strong rather close punctures, and a strong shining median smooth stripe; process of labrum broad, emarginate; front dull, striate-punctate; facial foveæ velvety-black, short, reaching scarcely below level of antennæ, not widely separated from eye; cheeks broad, sparsely punctate; antennæ dark, third joint longer than 4 + 5; thorax throughout dull and granular, the area of metathorax merely granular, and ill-defined; tegulæ dark, covered with hair; wings dusky, somewhat violaceous at apex; stigma and nervures rather pale brown, stigma not large; first r.n. joining second s.m. beyond its middle, second s.m. not narrowed above; anterior and middle femora with long yellowish-white hair, hind with black; hair of tibiæ fuscous, as also that of tarsi except the ferruginous brushes at the apices of the segments; abdomen broad, rather shining, not punctured, with rather long erect ochreous hair on segments 1 and 2, and broadly on apical margins of the following two, the hair otherwise, including that of apex, black; second abdominal segment depressed about one-third or slightly more (in all my descriptions the proportion given refers only to the *visible* part of the segment)

Type from Florissant, June 13, fls. *Ribes;* the specimen is stylopized.

The following table separates three allied species:

Pubescence dull, with much black hair on upper part of head *ribesina* Ckll.
Pubescence bright yellow, without black hair on upper part of head.
  Clypeus closely punctured . . . . . *hirticincta* Provancher
  Clypeus shining, sparsely punctured . . . . . *mentzeliæ* Ckll.

A. mentzeliæ occurs as far north as Fort Collins, Colorado, where it has been taken by Mr. Titus.

In Mr. Viereck's tables of northwestern species, *A. ribesina* runs to *A. saccata*, but that has the pubescence of face black. It is not in Robertson's tables.

41. **Andrena topazana**, sp. nov.

♀. Length about 10 mm.; black; head and thorax with long hair, which is pale fulvous dorsally, yellowish-white below, but blackish on cheeks and on face below antennæ; facial quadrangle broader than long; clypeus with distinct but sparse punctures, shining in middle; front finely striate; process of labrum broad and truncate; antennæ dark, faintly brown at apex, third joint about as long as 4+5; facial foveæ with brownish-black tomentum, broad, extending a little below level of antennæ, and upwards to level of lateral ocelli, not separated from eye; thorax dull and granular, area of metathorax merely granular and scarcely defined; tegulæ dark; wings dusky, stigma pale brown, nervures darker; first r.n. joining second s.m. much beyond middle; legs black, the femora with long white hair; curled floccus on hind trochanters very large and white; hair of tibiæ and tarsi dark fuscous, a little redder on inner side of the broad basal joint of hind tarsi; abdomen dull, not punctured, with sparse pale hair, long on first segment; a certain amount of inconspicuous black hair on third and fourth segments; fimbria black; ventral segments with long fringes of pale hair; second dorsal segment depressed at least one-half in middle.

Type from Topaz Butte, June 17 (R.).

Not in Robertson's or Viereck's tables. It is somewhat allied to *A. dunningi.*

42. **Andrena runcinatæ**, sp. nov.

♀. Length about 10 mm; black; head and thorax with coarse hair, black on mesothorax and scutellum, largely on vertex, and to some extent on sides of face overlapping foveæ, but otherwise white, with no ochreous tint; facial quadrangle broader than long; clypeus shining, with sparse strong punctures, the anterior middle smooth, but no median ridge; process of labrum very broad, low and rounded; cheeks swollen, shining, with very fine punctures; facial foveæ dark, not separated from eye, and not very long; antennæ dark, third joint longer than 4+5, the latter are very short; thorax dull and granular, the scutellum only shining; area of metathorax merely granular, ill-defined; tegulæ piceous; wings dusky, stigma rather pale brown, nervures darker; second s.m rather narrow, receiving first r.n. near its end; third s.m. very long; legs black, the hair on femora white, on tibiæ and tarsi fuscous; spurs pale yellowish:

abdomen shining but not punctured, rather narrow; second segment depressed about one-third; second to fourth segments with thin bands of rather long white hair; fimbria black.

Type from Florissant, July 22, fls. *Crepis runcinata* (R.). Two females were taken, and with them a male which is provisionally referred to *A. runcinatæ.* This is much smaller than the ♀, length about 7 ½ mm.; hair of head and thorax long and all white; head large; cheeks broad and flat, with a not very conspicuous posterior angle somewhat below level of middle of eye; face black, with much white hair; antennæ all dark; legs black, the small joints of tarsi brownish; hind margins of abdominal segments 2 to 4 with bands of long white hair, copious and conspicuous. In Robertson's table this would run to 13, but it agrees neither with *erythronii* nor *platyparia.* In Viereck's table it would run to *viburnella*; I possess only the ♀ of *viburnella*, which is very different from ♀ *runcinatæ.* The latter is not in Robertson's or Viereck's tables.

43. **Andrena lewisii,** sp. nov.

♀. Length 10½ mm.; hair of head and thorax dull white, not dense; clypeus bare, the disc very shiny, with strong well separated punctures, a smooth region in the middle, but no ridge; process of labrum broad, truncate; facial foveæ broad, light seal-brown, extending about as low as upper level of clypeus not separated from eye; antennæ dark, flagellum faintly brown, third joint about as long as 4 + 5; mesothorax dull, minutely roughened, with shallow punctures; area of metathorax granular, ill-defined, with vestiges of wrinkles at base; tegulæ dark brown; wings dusky, stigma rather small, dilute brown, nervures rather darker; first r. n. joining second s.m. far beyond its middle; legs black, with white pubescence, pale reddish on inner side of tarsi; abdomen with a sericeous surface, not punctured; segments 2 to 4 with apical bands of long white hair, not very dense; fimbria pale ochreous; second segment in middle depressed rather more than one third, but much less than half.

Florissant, July 15, two at fls. *Linum lewisii* (C.); also July 11, fls. *Polemonium* (R.), and July 6 (R.).

This is not in Viereck's tables; in Robertson's it runs to *A. salicacea*, except as to joint 3 of antennæ. It may be compared with *A. clypeonitens*, which has the fimbria quite a different color; and is much like *A. macgillivrayi*, but differs from that by the dull first abdominal segment and broader facial foveæ.

44. **Andrena fragiliformis**, sp. nov.

♀. Length about 9 mm.; black, even to tarsi; hair of head and thorax dul white, rather scanty; clypeus dullish, convex, with numerous rather shallow punctures; process of labrum very broad, truncate; front minutely striate; facial foveæ short and inconspicuous; antennæ dark, flagellum faintly brownish beneath; joint 3 about as long as 4 + 5; hair of legs dull white, pale reddish on inner side of tarsi; thorax dull and roughened, area of metathorax scarcely defined; tegulæ rufopiceous; wings yellowish; stigma large, ferruginous, the nervures browner; first r.n. joining second s.m. near middle; abdomen sericeous, not punctured, with very thin bands of long white hair on the margins of second and following segments; fimbria pale, with a yellowish tint; second segment depressed about one third; margins of segments narrowly subhyaline.

Florissant, June 29 (C.). Very close to *A. fragilis* Sm. (*platyparia* Rob.), but the metathorax and the basal segment of the abdomen are much broader, and the hair of the thorax above is differently colored. It seems also to resemble *A. arabis*, but it is too small, and the process of labrum is different.

45. **Andrena synthyridis**, sp. nov.

♀. Length about 10 mm.; black; head and thorax with long dull white hair; clypeus bare and prominent, shining, with strong well-separated punctures, no median line; process of labrum broad, rather narrowly truncate, with sloping sides; cheeks rather small; facial foveæ seen from above pure white, narrow, scarcely reaching below level of antennæ; third antennal joint slightly longer than 4 + 5: flagellum faintly brownish; mesothorax and scutellum rather shiny, with small but distinct irregularly-placed punctures; area of metathorax rather small, ill-defined, granular; legs black with pale hair, more or less stained with fuscous on tibiæ and tarsi, that on inner side of hind tarsi pale yellowish; tegulæ dark; wings almost clear, stigma and nervures rather light reddish brown; first r.n. joining second s.m. at middle; abdomen shining but sericeous, with hair-punctures; lateral hind margins of second and third segments with shining white hair; fimbria dull pale brownish; second segment in middle depressed hardly one third, and less than one fourth at sides.

Florissant, June 16. Three at fls. *Synthyris plantaginea* (C.). Much like *A. sapellonis*, but facial foveæ narrower.

46. **Andrena sieverti**, sp. nov.

♀. Length 10 mm. or slightly over; robust, with broad abdomen; black, the small joints of tarsi becoming brownish; head and thorax with dull white hair; clypeus very shiny, with sparse punctures; process of labrum small and inconspicuous, narrow; facial foveæ white with a brownish tint, narrow, extending a little below level of antennæ; antennæ dark, third joint slightly longer than 4 + 5, these latter short; thorax dullish, with scattered punctures, scutellum shining; area of metathorax dull, granular, hardly defined; legs with white hair, faintly yellowish on inner side of hind tarsi; basal joint of middle tarsi broad; tegulæ dark reddish; wings nearly clear, stigma rather small, reddish brown; first r.n. joining second s.m. at or beyond middle; abdomen moderately shiny, with very small punctures; hind margins of segments 2 to 4 with dense bands of pure white hair; fimbria slightly yellowish; second segment depressed about one-third.

Florissant, July 24 (R.); probably at fls. *Erysimum*.

Runs in Bruner's tables to *imitatrix* Cress., which however (*fide* Viereck) is a *Trachandrena.* It is closely similar to *A. bridwelli* Ckll., but easily separated by the shining clypeus, and more feebly punctured abdomen.

47. **Andrena lappulæ**, sp. nov.

♂. Length a little over 8 mm.; black, with abundant long white hair on head and thorax, faintly yellowish on scutellum; face transversely oblong, facial quadrangle conspicuously broader than long; clypeus shining, creamy white with two black dots, and sparse feeble punctures; lateral marks small, subpyriform, on each side of clypeus; cheeks rounded; process of labrum rather narrow, truncate-emarginate; front dull, finely striate; antennæ black, joint 3 about as long as 4 +5, 5 conspicuously longer than 4; mesothorax sparsely and feebly punctured, very shiny in middle, dull near margin; scutellum very shiny in front; area of metathorax scarcely defined, with almost microscopical striæ at base; tegulæ whitish with a brown spot; wings hyaline, slightly yellowish; stigma and nervures dark ferruginous; first r.n. joining second s.m. a little beyond the middle; legs black with white hair, small joints of tarsi ferruginous; spurs yellowish white; abdomen shining but with a rather sericeous surface and minute hair-punctures; hind margins of second and following segments with white hair-bands; second segment depressed about one-quarter.

Florissant, five, July 19, fls. *Lappula floribunda* (C.).

Runs in Bruner's table (this part based on an earlier one of mine) to *A. capricornis*, but it is not that species. Of all the females from Florissant, it could belong only to *A. sieverti*; that it may be the male of that species cannot be denied, but in the absence of any proof, it is given a separate description and name.

Andrena spp. Ten species, represented only in the male sex, are put aside for treatment at some later date. Some are doubtless new, but others may belong to described females. Four are from Topaz Butte, June 17 (R.), one of these from flowers of *Heuchera bracteata.* One visits *Sidalcea neomexicana*, one *Edwinia*, one *Polemonium*, one *Dasiphora*, one *Chamærhodos erecta*, and one (a small species near *A. salicinella*) was flying round a *Ribes* bush not in flower.

48. **Nomada ornithica** *Ckll.* 1 ♂, June 29, fls. *Edwinia* (R.). The specimen is larger than the type, and the metathorax has a large yellow mark on each side, but it is otherwise the same.

49. **Nomada taraxacella** *Ckll.* 1 ♀, June 21, fls. *Senecio* (R.).

50. **Nomada crawfordi** *Ckll.* 14 ♂, 2 ♀. The females are from east of Lake George. June 18 (C., R.), fls. *Senecio.* The males are eleven from east of Lake George, June 18 (C., R., W. P. C.), fls. *Senecio*, and one *Halerpestes cymbalaria*; three at Florissant, June 20 and 21, fls. *Senecio* (two) and *Draba* (R.). The species was previously known

by a single female. The male runs in my tables of Rocky Mountain *Nomada* to *N. superba*, but is smaller than that, yet not nearly so small as *luteopicta*. The tegulæ are yellow; the apical plate of abdomen is variable, notched or truncate. Eyes of ♂ in life pea-green.

51. **Nomada ruidosensis** *Ckll.* 4 ♂, and one ♂ var. Eyes in life dark red (R.). Two June 21, fls. *Senecio* (R.); one July 10 (R.); one east of Lake George, June 18, fls. *Chamærhodos erecta* (R.). One, June 21, fls. *Senecio* (R.), is a large variety, with much yellow on the scutellum. This species is curiously like *N. fragilis*, but certainly distinct. They show some variation from the type:—scutellum with a pair of minute yellow spots, or (in one) quite large ones; first abdominal segment with an interrupted yellow band, more or less developed; venter of abdomen often largely yellow.

52. **Nomada rohweri**, sp. nov.

♀. Length about 10 mm.; head and thorax densely punctured, black marked with red, the scanty pubescence also red; clypeus except upper border, lateral face-marks (broad below, narrowing a little below level of antennæ, then broadning, ending in a point not very far from top of eye), labrum, mandibles except tips, vaguely indicated stripe behind eye, two large marks on prothorax, tubercles, tegulæ, rather obscure mark on pleura, and scutellum, all ferruginous; postscutellum with a deep orange band; first joint of labial palpi at least three times as long as second; antennæ entirely red, third joint above about as long as fourth, flagellum stout; mesothorax very rough, with contiguous punctures, it and the metathorax entirely black; scutellum prominent, only moderately bilobed; tegulæ large, punctured; wings rather dusky, especially at apex, which is quite dark, with a contrasting colorless area beyond the cells; stigma bright ferruginous; nervures mostly fuscous, the more basal ones ferruginous; b.n. meeting t.m.; second s.m. exceedingly broad, receiving first r.n. at about beginning of last third; third s.m. much narrowed above; legs red, the coxæ black, middle and hind trochanters partly black, middle femora and tibiæ with some black spots behind, hind femora black behind and strongly suffused with black in front; hind tibiæ with a large black mark behind; hair on inner side of hind tarsi orange-golden; anterior coxæ with a strong red spine; abdomen with exceedingly minute punctures, hardly noticeable with a lens; first segment red with a small black spot on each side; remaining segments very pale yellow or cream-color, the second with the basal middle red, pointed posteriorly, and the extreme base at sides black; third black at base, the hind margin of third and fourth narrowly red; lateral base of fifth narrowly black; venter red, stained with black.

♂. Length about 8 mm.; much like the ♀, but smaller; clypeus except upper margin, labrum, mandibles except apex, lateral face-marks (ending abruptly about level of antennæ), tubercles and two small spots on prothorax very pale yellow; scape rather swollen, pale yellow in front; third antennal joint about half as long as fourth; joints 5 and 6 black above, the joints beyond except the last with more or less of a black mark above; both middle and hind femora black behind, the hind femora also black in front, but the apex broadly pale yellowish and the upper edge reddish; all the tibiæ pale yellowish at apex; basal half of first abdominal segment black; apical plate conspicuously notched.

Eyes in life deep red in ♀, light red in ♂.

Type (♀) east of Lake George, June 18, fls. *Senecio* (R.). One male east of Lake George, June 18, fls. *Geranium* (W. P. C.), and one male Florissant, June 30, fls. *Sedum stenopetalum* (R.).

The ♀ is near *N. snowi*, but differs by lack of light lateral face-marks, etc.

The ♂ in the tables of Rocky Mountain *Nomada* runs to *snowi*, but differs by having the pleura all black, etc.

53. **Nomada cymbalariæ**, sp. nov.

♀. Length 8 mm.; red head; and thorax strongly punctured; mandibles simple; face broad, black between and a little above antennæ, also between ocelli and on posterior part of cheeks, as well as the usual small mark on each side of clypeus; antennæ entirely red, third joint a little shorter than 4; mesothorax with a black median stripe; region between wings and hind legs black; metathorax with a broad black median stripe; scutellum not very prominent; wings strongly dusky apically, stigma ferruginous, nervures fuscous; b.n. a moderate distance basad of t.m.; second s.m. large, much higher than its breadth on marginal, receiving r.n. a little beyond middle; legs red, the femora black beneath at base, the black extending over most of the posterior face of hind femora, its edge not defined; hind tibiæ blackish behind; hind tarsi with hair on inner side somewhat dusky; abdomen minutely punctured; first segment with a black mark in the middle at base and one at each side, its hind margin also blackened, as are the hind margins of the following three segments to a less extent; segments 2 to 4 with bright yellow lateral marks; 5 with a pair of large yellow dorsal marks, 6 with similar marks, but joined in the middle line; venter red, slightly stained with black.

Type from east of Lake George, June 18, fls. *Halerpestes cymbalaria* (R.).

In the table of Rocky Mountain *Nomada* this runs to *N. luteopicta*, from which it differs by the black at base of abdomen, etc. There is no yellow whatever at lower corners of face. The median black mark at base of abdomen is transversely oblong, with a small band extending from its middle to the base.

54. **Halictoides harveyi** *Ckll.* 1 ♀, 4 ♂. The ♀ July 15, fls. *Dasiphora* (R.). Males July 11–16; three at flowers of *Dasiphora fruticosa* (C., R.), one at *Polemonium* (R.).

55. **Panurginus cressoniellus** *Ckll.* 9 ♂, 15 ♀. Males July 8–20, at flowers of *Dasiphora fruticosa* (C., R.), *Linum lewisii* (C.), *Sidalcea neomexicana* (W. P. C.) and *Polemonium* (R.).

Females, Topaz Butte, June 17 (R.), and Florissant July 16–24, at flowers of *Dasiphora* (R., C.), *Argentinia* (R.), *Anogra coronopifolia* (R.), *Geranium* (R.), *Polemonium* (R.) and *Sidalcea neomexicana* (R.).

56. **Spinoliella scitula** *Cress.* 26 ♂, 23 ♀. ♂ eyes in life light bluish gray. 24 ♂ and 20 ♀ were from a colony nesting at Lake George, discovered by Dr. W. M. Wheeler, and excavated by my wife and Mr. Rohwer, July 5. The pollen-masses were found to be globular, in small cells in the ground; the diameter of the masses, when dry, is a little over 2 mm.

At Florissant, males were taken July 17 and 22, one fls. *Scrophularia* (R.). Three females were taken July 22 (R.), probably at *Argentinia*.

57. **Calliopsis coloradensis** *Cress.* 1 ♀, 1 ♂, both July 17 (C.). Eyes of male in life pea-green.

58. **Calliopsis rhodophilus** *Ckll.* 2 ♂, July 17 (C.); one fls. *Potentilla*. Eyes of male in life pea-green. I also took 2 ♂ at Colorado Springs, June 20.

59. **Perdita zebrata** *Cress.* 1 ♂, a form with face-markings creamy-white. At flowers of *Cleome serrulata*, July 21 (C.).

60. **Perdita tortifoliæ**, sp. nov.

♀. Length 4½ mm.; head and thorax very dark green, abdomen black without spots or bands; maxillary palpi 6-jointed; mandibles cream-color on basal half, ferruginous on apical; clypeus black, shining, very sparsely punctured; lateral marks (the only light marks on face) cream-color, very small, subquadrate, on each side of clypeus; front dullish, minutely granular; flagellum testaceous beneath; mesothorax very smooth and shiny, with very little hair; scutellum the same, but metathorax dullish; tegulæ cream-color; wings clear, very iridescent, stigma colorless with brown margin; nervures brown, the outer ones distinct; marginal cell rather obliquely truncate; second s.m. large; legs black, the anterior knees, anterior tibiæ except somewhat behind and their tarsi pale lemon yellow; middle tibiæ yellow on outer side; apical plate of abdomen unusually long and narrow.

Florissant, July 25, two at flowers of *Bigelovia* (or *Chrysothamnus*) *tortifolia*. Flying with them, I caught two specimens of what I supposed to be the male of *P. tortifoliæ*, but they proved to be females of *P. florissantella*. On July 22, Mr. Rohwer took a single ♀ *tortifoliæ* at *Ranunculus eremogenes* Greene.

In my Proc. Phila. Acad. table this runs to *P. semicærulea*; it is like that species as to face-marks, but is easily distinguished by the much less hairy head and thorax, with nude shining dark green mesothorax, etc.

61. **Perdita florissantella**, sp. nov.

. Length about 3½ mm.; head and thorax very dark green; mesothorax and scutellum smooth and very shiny, front dull and granular; face below level of antennæ all yellowish-white or creamy, except that clypeus has the usual dots, and the supraclypeal region is mostly shining black; maxillary palpi 6-jointed; scape cream-colored in front, flagellum black; nervures and margin of stigma brown; marginal cell obliquely truncate; legs black, anterior and middle tibiæ and knees pale yellow, their tarsi with the first joint white and the small joints pale brownish; abdomen black, with a broadly interrupted yellow band at base of second segment, and sometimes some yellow at sides of the following three.

♀. Length 5 mm.; similar to male, but abdomen without yellow marks, and face-marks different; clypeus except the usual dots, labrum, rather large hemispherical lateral marks and a reniform supraclypeal mark all yellowish-white.

Florissant, July 19, many at flowers of *Eriogonum umbellatum* (C.). Two females were taken at *Bigelovia tortifolia*, as related above.

The male in my Proc. Phila. Acad. table runs to 26, and runs out because the abdominal marks are yellow. The ♀ runs to *asteris* var., or if without supraclypeal mark to *californica* var. It is quite distinct from these species.

62. Perdita wilmattæ, sp. nov.

Length nearly 5 mm. ♂. Head and thorax dark green; face-marks white including clypeus, broad supraclypeal mark notched above, dog-ear marks, and large lateral marks shaped like the mainsail of a schooner and ending on orbital margin at an angle of about 50° at the level of the antennæ; antennæ cream-color beneath, except the last three joints, which are blackened; front dullish blue rather than green; mesothorax very shiny, with little hair; wings clear, nervures and stigma pale yellowish; marginal cell very short and broad; second s.m. much narrowed above; second r.n. practically obsolete; anterior and middle knees broadly and their tibiæ in front light yellow, their tarsi whitish; hind knees very broadly yellowish white; abdomen black with six broad very pale yellow bands, the first notched in front and not reaching lateral margins; none of the bands are joined on lateral margins; venter pale yellowish, marked with fuscous.

♀. Similar, but with only five abdominal bands; no dog-ear marks; supraclypeal mark reduced to two spots; lateral marks more triangular; apical joints of antennæ not dusky beneath.

Florissant, July 21–22, very many at flowers of *Phacelia alba*; first found by W. P. C., also collected by R. and C. The name of the *Phacelia* has been kindly confirmed by Prof. Aven Nelson.

Close to *P. zebrata* (from which it presumably evolved); the ♂ is easily known from *zebrata* by the white face-marks and shape of lateral marks; the banding of abdomen also differs. The male in my tables runs to *bakeræ* or *zebrata*. The female in the tables runs near *bigeloviæ* or *nitidella*, or if having a supraclypeal mark to *zonalis*. It differs from *bigeloviæ* by its smaller size, shape of lateral face-marks, etc.; it is also quite different from the other two. The New Mexico *Perdita* table suggests affinity with *P. mentzeliarum*, but that has the abdomen entirely different. From *P. snowi* it is easily known by the shining mesothorax.

63. **Epeolus beulahensis** *Ckll.* One of each sex, east of Lake George, June 18 (R., C.).

64. **Phileremus americanus** *Cress.* 7 ♀, east of Lake George, (R., C., W. P. C.); one at *Senecio*, one at *Geranium*. 4 ♂, Florissant, June 21–22 (R.); two at *Senecio*, two at *Erigeron*.

Oreopasites, gen. nov. (Philereminæ.)

Mandibles simple; tongue long, broadly linear, surpassing lateral palpi-labial palpi 4-jointed, first two joints long, the first nearly twice as long as second; galea long and narrow; paraglossæ hyaline, linear, reaching a little beyond middle of first joint of labial palpi; maxillary palpi minute, hardly half length of first joint of labial palpi; 6-jointed, first joint a mere tubercle, second longest, then third, then 4 and 5 equal, sixth oval, rather more than half length of second; labrum larger, oblong, elongated, the broadest part about one fourth from base; third antennal joint nearly as long as 4 + 5, the latter broader than long; thorax with fine white copiously plumose hair, and long bristle-like hairs; claws simple (♀); hind spur microscopically serrate-denticulate (♀); stigma well formed; marginal cell broadly obliquely truncate, with a small appendicular nervure; b.n. meeting t.m.; first s.m. much shorter than second (which is morphologically 2 + 3); second receiving both recurrent nervures, the first not nearly so close to its beginning as the second to its end.

The first s. m. shorter than second recalls *Biastes*. The insect runs in Ashmead's table to *Chilicola*, which differs entirely in the venation. The labrum is quite different from that of *Phileremus americanus* (which has it short and transverse); the maxillary palpi are also entirely different, and the tongue is longer.

65. **Oreopasites scituli**, sp. nov.

♂. A little over 5 mm. long; rather slender; black, the first abdominal segment with broad apical margin and a pair of spots near base obscure ferruginous; ventral surface of abdomen dark brown; apical half of the sharp and slender mandibles bright ferruginous; hair of head, thorax and legs rather scanty, silvery white; second and following abdominal segments with the lateral hind margins fringed with rather long white hair, on the fifth and sixth this forms a band right across the segment; head round seen from in front; eyes parallel; anterior margin of clypeus very shiny; ocelli prominent, in a curve; malar space short but distinct; antennæ dark; flagellum stout, thickest near apex; thorax small, mesothorax shiny, sparsely punctured; tegulæ piceous; wings hyaline, stigma and costal nervure dark brown, the other nervures pallid; first r.n. joining second s.m. about as far from its base as from the insertion of second r.n.; legs black, including spurs; abdomen shining, with very fine punctures; apical plate rounded.

♀. Nearly 5½ mm. long; more robust; first two abdominal segments dull ferruginous, with a large transverse black mark, that on the second more distinct; sides of third segment more or less ferruginous; apex terminating in a small emarginate process.

Lake George, July 5 (W. P. C.). When the nest of *Spinoliella scitula* was excavated, the male was found in it, along with numerous specimens of *Spinoliella.* The pollen-balls of the *Spinoliella* were found by my wife to have attached to them certain quite large larvæ, with the dorsum strongly tuberculate. These were placed in a small bottle, with their food, and were supposed to belong to the *Spinoliella.* Later, however, it was found that a ♀ *Oreopasites* had hatched, while two or three others had perished when just on the point of hatching, and already colored.

66. **Anthophora neomexicana** *Ckll.* 2 ♀, 2 ♂. Eyes of ♀ in life black. Females, June 15 (R.) and July 11, fls. *Polemonium* (R.). Males, June 14 (R.) and June 16, fls. *Iris missouriensis* (C.).

67. **Anthophora simillima** *Cress.* 2 ♀. Eyes in life sea-green. June 15 and 20 (R.), one at fls. *Pentstemon.*

68. **Anthophora** (**Micranthophora**) **flexipes** *Cress.* 2 ♂. Eyes in life green, bluer in middle, yellower at top and bottom. July 17 (C.)

69. **Clisodon terminalis** *Cress.* 2 ♀, 2 ♂. Eyes of male in life olive green. Females, July 20–21, fls. *Pentstemon* (R.). Males, July 6, fls. *Mertensia* (R.), and July 15, fls. *Linum lewisii* (C.).

70. **Emphoropsis mucida** *Cress.* 1 ♀. June 16, fls. *Ribes longiflorum* (C.).

71. **Melissodes pallidicincta** *Ckll.* 9 ♀. Eyes in life blue-gray. June 15–July 22; fls. *Iris missouriensis* (W. P. C., C.), *Polemonium* (R.), *Crepis runcinata* (R.), and east of Lake George, June 18, fls. *Senecio* (W. P. C.).

72. **Melissodes menuacha** *Cress.* 1 ♂, July 23, fls. *Sidalcea neomexicana* (W. P. C.). This is not typical *menuacha;* it has the hair of the head and thorax white, like that of a form I have taken at Santa Fé, New Mexico, visiting *Grindelia;* but the latter differs somewhat in the antennæ and venation. There are perhaps two or three species mixed under *menuacha.*

73. **Melissodes confusa** *Cress.* 1 ♀, July 2, fls. *Pentstemon* (R.).

74. **Melissodes hymenoxidis**, sp. nov.

♀. Length about 10 mm.; eyes in life blue-gray. Related to *M. perplexa,* but differing as follows: hair of lower part of face mainly black, of mesothorax pale ochreous, except posteriorly where there is a large, shining, sparsely punctured area, with rather sparse black hairs; scutellum less strongly punctured, and black hair less conspicuous; *hair of pleura black;* second s.m. larger; marginal cell more pointed; abdominal bands slightly yellowish.

Compared with *M. confusa* it is more shining and not so large, and is easily distinguished by the black hair of pleura, etc.

Compared with the Mexican *M. raphaelis* it differs by the black hair of cheeks; the much larger amount of pale hair before the black on mesothorax dark flagellum, etc.

In my table in Trans. Amer. Ent. Soc., 1906, p. 113, it runs to *M. simillima*, from which it is easily known by the black hair of pleura and the much less conspicuous patch of black hair on thorax above.

The hair of the labrum is black; clypeus extremely densely punctured, with a little space in middle shining and not so closely punctured; spurs ferruginous.

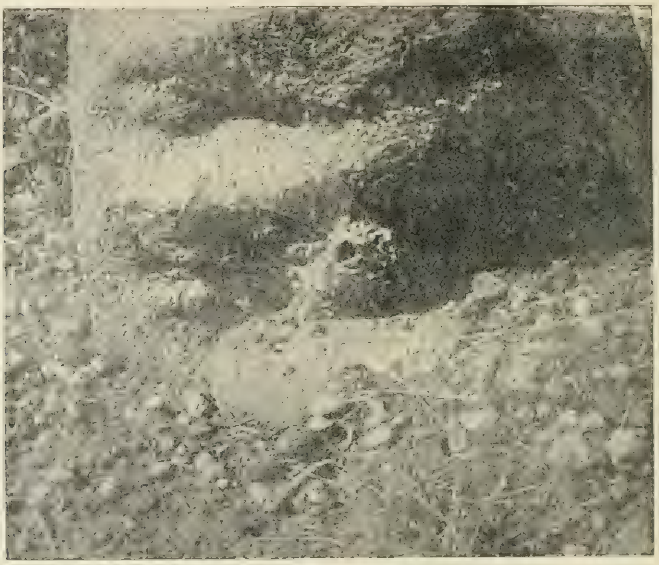


Fig. 1. Nest of *Dianthidium cressonii*, built of resin and pebbles on the surface of a stone.

Three females, July 17 (C.). Two were seen to visit successively *Hymenoxys ligulæflora (Hymenopappus ligulæflorus*, A. Nelson, 1896) and *Chrysopsis*.

75. **Ceratina neomexicana** *Ckll.* 1 ♀, July 1, fls. *Senecio* (R.).

76. **Anthidium emarginatum** *Say.* 5 ♂, 8 ♀. Eyes of male in life sea-green; of female sea-green, with the basal quarter black Females, June 15–July 22, fls. *Sedum* (R.), *Gilia* (R.), and *Phacelia* C.)(. Males, June 15-July 22, fls. *Sedum* (R.) and *Pentstemon* (W. P. C. .

77. **Anthidium maculosum** *Cress.* 1 ♀, June 15 (R.). Eyes in life with the anterior three fifths black, posterior two fifths sea-green.

78. **Dianthidium cressonii** *D. T.* 1 ♀, July 22 (C.). It was at a large resin nest on a granite boulder; this nest was found and photographed by Dr. Wheeler.

79. **Chelynia elegans** *Cress.* 2 ♂, July 1 and 12 (R.). One was probably at *Helianthella parryi*. This and the next species were described under *Stelis*.

80. **Chelynia monticola** *Cress.* 2 June 21, one at fls. *Senecio*, (R.).

81. **Stelis montana** *Cress.* 2 ♂, June 21, one at fls. *Draba* (R.). 2 ♀, July 1, one fls. *Senecio*, the other probably *Helianthella parryi* (R.).

82. **Alcidamea simplex** *Cress.* 2 ♂, June 21, fls. *Erigeron* (R.). 1 ♀, July 12 (R.).

Titusella, gen. nov. (Heriadinæ.)

♀. Small bees, with a very large head; clypeus smooth and shining, emarginate; mandibles very broad, with a long cutting edge, on which are three teeth, and (basally) a long somewhat undulating edge representing a fourth tooth; maxillary palpi 4-jointed, joint 2 longest, 3 and 4 subequal, but 3 a little the longer; first joint of labial palpi a *little shorter* than second (first about 675 *v*. second about 750 *v*); claws simple; pulvillus distinct; no malar space; venation resembling *Ashmeadiella;* spurs dark; scopa light orange. Named after Mr. E. S. G. Titus, in recognition of his work on this group. Its position is best defined by the following table:

Maxillary palpi 3-jointed . . . . . *Heriadis* and *Chelostoma*
" " 5-jointed . . . *Andronicus*, *Alcidamea*, and *Hoplitis*
" " 4-jointed.
  First joint of labial palpi less than one-third as long as second; clypeus (♀) broadly emarginate; first abdominal segment rounded at base, with a narrow sulcus . . . . *Prochelostoma* Rob.
  First joint of labial palpi not quite half length of second; clypeus truncate; first abdominal segment rounded at base, with a narrow sulcus . . . . . . *Robertsonella* Titus
  First joint of labial palpi two-thirds length of second; ♀ unknown; second s.m. shorter than first . . . . *Proteriades* Titus
  First joint of labial palpi longer than second or about equal with it; clypeus (♀) normal, punctured; first segment at base with a wide impunctate concavity . . . . . *Ashmeadiella* Ckll.
  First joint of labial palpi nine tenths length of second; clypeus (♀) smooth and shining, deeply emarginate; first abdominal segment at base with a wide impunctate concavity; second s.m. not shorter than first; first s.m. on marginal cell longer than stigma on marginal . . . . *Titusella* Ckll

In Robertson's table (Trans. Am. Ent. Soc. 1903, p. 166–167) it runs to *Ashmeadiella*, from which it has presumably been derived.

83. **Titusella pronitens**, sp. nov.

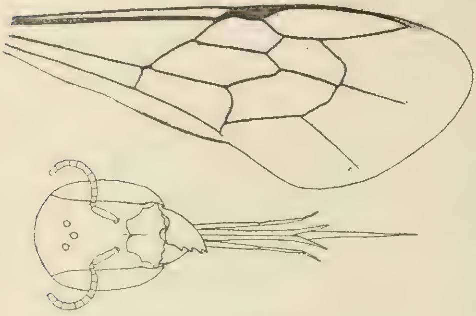


Fig. 2. *Titusella pronitens*, gen. et. sp. nov. Fore wing and head.

♀. Length about 8 mm.; black; head and thorax shining, with strong, well separated punctures; head very large, larger than thorax, the cheeks and vertex very broad; hair of head and thorax rather scanty, dull white; anterior face of mandibles near apical margin with appressed golden hair; clypeus smooth, shining, not punctured, its anterior edge broadly emarginate in middle the edge on each side of the emargination undulated; antennæ rather short, black; a small smooth depressed line proceeds backwards a short distance from the outer margin of each posterior ocellus; tegulæ shining black; wings slightly dusky, nervures black; legs black, including spurs, their hair white, that on inner side of hind tarsi orange; abdomen above with the first four segments very shiny, each with a narrow band of white hair on the apical margin; last two segments duller and punctate; ventral scopa entirely light fulvous or orange.

3 ♀, June 11, fls. *Senecio* (R.); June 22, fls. *Senecio* (R.); June 29. fls. *Edwinia* (R.).

84. **Monumetha albifrons** *Kirby*. 12 ♀, 14 ♂. Females, June 15–July 21, fls. *Edwinia* (R.), *Polemonium* (R.), a white-flowered *Carduus* (Wheeler), *Sidalcea neomexicana* (W. P. C.) and *Pentstemon secundiflorus*, six (C.). Males, June 15–July 12, fls. *Halerpestes cymbalaria* (R.), *Erigeron* (R.), *Senecio* (R.), *Draba* (R.), *Edwinia* (R.), *Sedum* (R.), and *Polemonium* (R.). East of Lake George, June 18.

Osmia *Panzer*.

The brilliant green species, *O. fulgida* and *bruneri*, are easily recognized, but the others require a table. I insert in the table *Stelis montana*, which is likely to be mixed with the species of *Osmia*.

	Small species, entirely black	*abjecta* Cress.
	At least the abdomen blue or green	1
1.	Males	2
	Females	6
2	Large and robust, abdomen deep blue, legs entirely black, antennæ not moniliform	*cyaneonitens* Ckll.
	Smaller	3

3. Hair of pleura black; small species, with much erect black hair *Stelis montana* Cress.
Hair of pleura white 4
4. Legs entirely black; antennæ conspicuously moniliform; abdomen beyond second segment with much erect black hair *O. faceta* Cress.
Legs at least partly submetallic; apical part of abdomen without erect black hair 5
5. A little larger; basal joint of hind tarsi longer, and obviously broader apically than basally . . . *chlorops* Ckll. and Titus
A little smaller; basal joint of hind tarsi shorter, and not much broader apically than basally . . . *wheeleri* Ckll.
6. Scopa orange . . . . *hypochrysea* Ckll.
Scopa black 7
7. Largest (at least 15 mm. long); hair of thorax above conspicuously fulvous; of pleura black . . . . *florissanticola* Ckll.
Smaller; hair of thorax above not fulvous 8
8. Clypeus smooth and shining; cheeks with a tooth beneath *armaticeps* Cress.
Not so 9
9. Large; hair of face mixed black and white, of pleura light; first abdominal segment with conspicuous light hair . . *densa* Cress.
Much smaller; or if only somewhat smaller, hair of face not so . 10
10. Rather large; hair of face all black, very coarse, of pleura black *nigrifrons* Cress.
Rather large; hair of face largely black, but conspicuous white hair at sides; legs all black . . . . *albolateralis* Ckll.
Small slender species, with very coarse black hair on face; hair of pleura light . . . . *pentstemonis* Ckll.
Hair of head and thorax all black; hair of ventral surface of abdomen scanty; form compact . . . . . . *Stelis montana* Cress.
Hair of head and thorax not all black; scopa normal; size smallish, form compact 11
11. Hair of face and vertex black; of pleura black but scanty; abdomen blue . . . . *O. wilmattæ* Ckll.
Hair of face black; of pleura black, abundant; of vertex and mesothorax mainly yellowish . . . . . *subtrevoris* Ckll.
Hair of face black; of vertex white; of pleura black, abundant *giliarum* Ckll.

85. **Osmia fulgida** *Cress.* 3 ♀, June 19–July 12, fls. *Polemonium* (R.).

86. **Osmia bruneri** *Ckll.* 5 ♀, June 15–July 21, fls. *Pentstemon secundiflorus* and *Pentstemon* sp. (R., C.).

87. **Osmia armaticeps** *Cress.* 2 ♀, June 21 and July 1, both fls, *Senecio* (R.).

88. **Osmia abjecta** *Cress.* 3 ♀, June 19–July 1, all fls. *Pentstemon* (R.). Described many years ago from a single example and apparently not reported since.

89. **Osmia faceta** *Cress.* 1 ♂, June 18, fls. *Senecio* (R.).

90. **Osmia densa** *Cress.* 2 ♀, July 12, fls. *Polemonium* (R.); July 21, fls. *Pentstemon secundiflorus* (C.).

91. **Osmia nigrifrons** *Cress.* 1 ♀, a small variety. June 21, fls. *Senecio* (R.).

92. **Osmia wilmattæ** *Ckll.* 2 ♀, July 21, fls. *Pentstemon secundiflorus* (C.).

93. **Osmia cyaneonitens**, sp. nov.

♂. Length 10 mm.; robust, with a short subglobose abdomen; head and thorax densely punctured, dullish, blue with green tints; abdomen brilliant steel blue, very shiny; hair of head and thorax dull white, quite long, especially abundant on scutellum; mandibles black, with the apical tooth sharp, the inner one truncate; edge of clypeus normal; antennæ black, the flagellum not moniliform; cheeks somewhat flattened; tegulæ large, piceous; wings a little stained with brown; legs black, the hair of anterior femora white, forming a long fringe behind, of middle and hind femora rather dilute black; hair of tibiæ and tarsi black, some white hair on anterior tibiæ and tarsi behind, and hair on inner side of anterior tarsi ferruginous; hind spurs black; first abdominal segment with very little pale hair; apical segment with inconspicuous erect black hair, with very few pale hairs intermixed; sixth segment with hind margin reddish and strongly (sometimes feebly) notched in the middle; seventh bidentate; venter black, first ventral segment entire.

2 ♂. June 15 and 19, both fls. *Pentstemon* (R.). In Robertson's tables it runs to *O. major* when the sixth segment is strongly notched; when it is feebly notched to *O. pumila*, except as to color. It is, of course, much larger than *pumila*. It resembles *O. integra* Cress., but the venter of the abdomen is quite different.

94. **Osmia chlorops** *Ckll. and Titus.*

. Length 9 mm.; olive green, apical part of abdomen with a bluish tint; head and thorax densely punctured, with long dull white hair; mandibles black, the outer tooth sharp, the inner truncate; clypeus normal; antennæ long and black, the flagellum moniliform; tegulæ piceous, anteriorly and on outer margin broadly green and punctured; wings faintly dusky; legs black, the femora with very faint metallic tints; hair of femora and tibiæ white, of basal joints of tarsi fuscous; basal joint of hind tarsi twice as broad at apex as at base; hind spurs black, strongly hooked; abdomen shining, the scanty pubescence white, long on first segment; sixth segment feebly notched; seventh strongly bidentate; first ventral entire.

Var. *a.* Flagellum ferruginous beneath; second s.m. shorter; sixth segment of abdomen strongly notched.

June 16, fls. *Iris missouriensis* (W. P. C.); var. *a.*, June 19, fls. *Pentstemon* (R.).

Runs in Robertson's tables to his genus *Monilosmia.* I give a new description from the Florissant material. The var. *a.* may be a distinct species.

95. **Osmia wheeleri**, sp. nov.

♂. Length 8 mm. or slightly more; olive green, slightly shaded with bluish, the apical part of abdomen strongly bluish; head and thorax densely punctured, with long dull white hair; mandibles black, the outer tooth pointed, the inner truncate; anterior edge of clypeus faintly crenulate; antennæ black, not moniliform; tegulæ piceous with a ferruginous spot in middle and a greenish punctured area in front; wings rather dusky; legs black the hind coxæ, femora and tibiæ more or less metallic; basal joint of hind tarsi normal; hind spurs not hooked; hair of femora scanty, mostly white, of tibiæ partly white and partly dark; the hair on inner side of basal joint of hind tarsi purplish-fuscous, contrasting with a short fringe of white hair on apex of hind tibiæ within; small joints of hind tarsi whitish-pruinose; abdomen shining, the very scanty hair partly light and partly dark; sixth segment strongly notched; seventh bidentate; first ventral entire.

Var. *a.* Sixth segment of abdomen feebly notched; second s.m. receiving the recurrent nervures nearly as far from apex as from base, whereas in the type the second r.n. is only half as far from apex as the first from base.

Florissant; June 15 (R.); June 19, fls. *Pentstemon* (R.). Var. *a.*, Cripple Creek, June 25 (R.). The var. *a.* is possibly a distinct species; Cripple Creek is more than a thousand feet higher than Florissant.

In Robertson's tables this runs to *O. atriventris* Cress., described originally from Connecticut. Cresson described only the female; Robertson (1902) held that *O. proxima* Cress., from Maine and British America, was its male; but Mr. Titus states that *O. proxima* is *canadensis* Cress., a species of Robertson's group *Monilosmia.* No description of ♂ *atriventris* has been published, but I do not believe our insect can belong there.

96. **Osmia hypochrysea**, sp. nov.

♀. Length 9 mm.; dark bluish green; head and thorax densely punctured, with long dull white hair; mandibles broad, with three pointed teeth; outer face of mandibles, near apical margin, with a broad band of orange hair, and similar hair also beneath margin of clypeus; *anterior margin of clypeus with a median tridentate elevation;* clypeus with a delicate longitudinal raised line; antennæ black; tegulæ shining black; wings dusky; b.n. meeting t.m.; the recurrent nervures join second s.m. about equally distant from its base and apex; legs black, with pale hair; hair on inner side of basal joint of hind tarsi black, but that on its hind margin becoming orange; spurs black; abdomen shining, strongly punctured, the scanty pubescence white; scopa entirely pale orange.

1 ♀, July 12 (R.). In Robertson's tables, runs to his genus *Xanthosmia. O. subfasciata* Cress. has a yellowish scopa, but has

not the clypeal structure of our insect. The female of *O. cordata* Rob. has not been fully described, but it must differ from *subfasciata* and *hypochrysca* by its larger size; it presumably has a normal clypeus. *O. coloradensis* Cress. is in many ways similar to our insect, but it is said to be "black, tinged with blue," which cannot possibly apply.

97. **Osmia florissanticola**, sp. nov.

♀. Length 15 mm.; head with shades of blue and green; thorax brassy green; abdomen greenish blue; head and thorax densely punctured; hair of thorax above, and of head above antennæ pale fulvous; hair of face below antennæ, cheeks, pleura, metathorax and legs black; a slight admixture of pale hairs at sides of metathorax; clypeus mostly black, its anterior edge straight; mandibles broad, with two large teeth; antennæ black; tegulæ black, closely punctured near margin; wings dusky; legs black, including spurs; abdomen shining, first two segments with light hair except at sides, where there is some black; remaining segments with black hair; scopa black.

2 ♀. June 16, fls. *Iris missouriensis* (C.); June 19, fls. *Aragallus* (R.).

In Robertson's arrangement this would be a *Centrosmia.* It differs from *O. novomexicana* Ckll., by the larger head and broader face, as well as the much less red color of the hair of thorax above. It is known from *O. grandior* Ckll., by the dark (not at all reddish-fulvous) hair of first four tarsi, and the color of hair on first abdominal segment, etc. From *O. longula* Cress., it differs by the straight (not subemarginate) anterior margin of clypeus, and strongly green and blue colors. From *O. juxta* Cress., it differs also by the bright colors, and by the elongated (not subglobose) form of the abdomen.

98. **Osmia albolateralis**, sp. nov.

♀. Length 11 mm.; dark blue green, the abdomen shining; head and thorax densely punctured, with mostly dull white hair, but that of the clypeus is black that of the cheeks dusky, the vertex has long black bristles, and the scutellum has a few black hairs mixed with the white; mandibles obscurely tridentate, none of the teeth long; clypeus normal; antennæ black; tegulæ dark fuscous, green in front; wings rather dusky; b.n. going basad of t.m.; first r.n. joining second s.m. fully three times as far from its base as the second r.n. from its apex; legs black, with scanty black hair; pale hair on anterior femora behind; basal joint of hind tarsi rather broad; hind spurs large.

2 ♀. June 21, fls. *Senecio* (R.); July 21, fls. *Pentstemon secundiflorus* (C.). Runs in Robertson's tables to *O. brevis*, but it is not that species. It may possibly be the ♀ of *O. cyaneonitens.* The type is the one from *Pentstemon.*

99. **Osmia pentstemonis**, sp. nov.

♀. Length about 9 mm.; dark blue, the mesothorax blackish; head and thorax densely punctured; head not unusually large; face and vertex with exceedingly long and coarse black hair; cheeks with very scanty short pale hair; thorax with white hair, long black bristles intermixed on dorsum; clypeus and mandibles normal; antennæ black, the flagellum dull reddish beneath; tegulæ piceous, blue in front; wings somewhat dusky, especially in marginal cell; first r.n. joining second s.m. about twice as far from base as the second from apex; legs black, the hind femora perhaps slightly metallic; hair of legs short and brownish-black, white on anterior femora behind; abdomen parallel sided; white hair on first segment, the others with very scanty black hair; apical segment with white pruinosity; scopa black.

4 ♀. June 15 (R.); June 19, fls. *Pentstemon* (R.); July 20, fls. *Pentstemon* (R.); July 21, fls. *Pentstemon secundiflorus* (C.).

In Robertson's table runs to *O. brevis*, but is not that species. It may prove to be the female of *O. wheeleri*.

100. **Osmia subtrevoris**, sp. nov.

♀. Length about 9 mm.; head dark blue; thorax and abdomen bluish-green, the latter subglobose, shining; head and thorax densely punctured; hair of thorax above pale yellowish, of vertex pale yellowish mixed with black; other hair of head and thorax all black, that of face long; head large; mandibles with two large sharp teeth; clypeus normal, with two little brushes of orange hair beneath anterior margin; antennæ black; tegulæ piceous, greenish in front; wings rather dusky; b.n. falling a little short of t.m.; first r.n. joining second s.m. about twice as far from base as second r.n. from apex; legs black, with black hair, including that of anterior femora behind; first abdominal segment with light hair, the others with black, but some light hairs at sides of second segment, and a very few on third and fourth; scopa black.

1 ♀. East of Lake George, June 18; fls. *Chamærhodos erecta* (R.).

Runs in Robertson's tables nearest to *O. brevis*, but is not that species. It is close to *O. trevoris* Ckll., but differs in the hair of tarsi and of thorax.

101. **Osmia giliarum** sp. nov.

♀. Length about 8 mm.; head and thorax dark green; abdomen greenish-blue; head and thorax densely punctured, their hair above dull white, as also at sides of metathorax, but otherwise it is black; mandibles and clypeus normal; antennæ black; tegulæ piceous; wings dusky; b.n. falling short of t.m.; first r.n. joining second s.m. not quite twice as far from base as second r.n. from apex; legs black, with black hair, including that of anterior femora behind; basal joint of hind tarsi rather broad; abdomen broad and convex, first segment and middle of second with white hair, the others with black; scopa black.

2 ♀. June 28, fls. *Gilia* (R.); July 12 (R.).

Runs in Robertson's tables to *O. brevis*, which it is not.

Megachile *Latr.*

I give a table for the separation of certain males:

	Anterior tarsi simple; hair of face tawny	*montivaga* Cress.
	Anterior tarsi peculiar	1
1.	Larger; anterior tarsi white, the basal joint not boat-shaped	*latimanus* Say
	Smaller; anterior tarsi with basal joint boat-shaped	2
2.	Boat-shaped scale with a black brush on inner margin at base	*pugnata* Say
	Boat-shaped scale without such a brush	*giliæ* Ckll.

102. **Megachile giliæ**, sp. nov.

♂. Length about 10½ mm.; black, with long erect dull white hair, fourth and following abdominal segments with some black on disc (rarely a little black on third); hair of face dense and very white; mandibles with the usual large tooth beneath; cutting edge with a large apical tooth, then two small ones, and the inner angle merely forming a right angle; edge of clypeus neither crenulate nor emarginate; antennæ black, the flagellum crenulate above, though not very strongly, last joint somewhat broadened; mesothorax closely punctured; tegulæ black; wings slightly dusky; anterior coxæ with a strong but blunt spine, and a patch of shining fulvous hair just above; anterior femora above pale fulvous, except the apex broadly and the apical half of the hind margin; behind, these femora are black, with long white hair; their tibiæ black with a broad pale band above, their tarsi yellowish white, the basal joint hollowed (boat-shaped), but little produced, the margins of the hollow fringed with fuscous hair; the hair-fringe behind white; second joint of anterior tarsi with an elongated black spot on inner side; the other legs normal; spurs light ferruginous; claws bifid at end, no basal tooth; hind margins of fourth and fifth abdominal segments with conspicuous white hair-bands; sixth concave, its projecting edge strongly emarginate; apex (beneath) with three short teeth, the middle one a little longer than the others.

3 ♂. June 19, fls. *Gilia* (R.); July 9, fls. *Gilia* (R.); July 15 (W. P. C.).

In Robertson's arrangement it would form a genus near to *Ceratias*. It has some resemblance to *M. wootoni*, but is easily distinguished by the bands on apical part of abdomen, lack of dark hair on thorax above, etc. From *M. gemula* Cress., it is easily known by the light hair of mesothorax; from *M. manifesta* Cress., by the structure of sixth abdominal segment; from *M. amica* Cress., by the structure and hair of anterior tarsi; from *M. legalis* Cress., by the form of sixth abdominal segment.

103. **Megachile wootoni** *Ckll.* 3 ♀, 5 ♂. Females July 14–20, fls. *Polemonium* (R.). One was seen to visit successively *Polemonium* and *Aragallus*. Males, July 9–20, fls. *Polemonium* and *Aragallus* (R.).

104. **Megachile wootoni rohweri**, subsp. nov.

♀. Smaller (length 11–12 mm.); cheeks with white hair; abdominal segments beyond the second with hair not all black, the margins of the segments fringed with light hairs, only conspicuous when seen from the side.

July 18, fls. *Polemonium* (R.); July 22, fls. *Pedicularis* (R.). This looks like a distinct species, and might even be thought to be the ♀ of *M. giliæ* (which is abundantly distinct from *wootoni* in the ♂) but for the existence of intermediates. On July 18, fls. *Polemonium*, and July 21, fls. *Pedicularis*, Mr. Rohwer took females of the normal size of *wootoni*, with the hair of cheeks partly pale.

105. **Megachile pugnata** *Say*. 3 ♀, 6 ♂. Females, July 17–26, fls. *Hymenoxys ligulæflora* (C.), *Epilobium* (R.) and *Asclepius speciosa* (R.). Males, June 19–July 12 (R.), fls. *Senecio*, *Gilia* and *Pentstemon*.

106. **Megachile latimanus** *Say*. 4 ♀, 1 ♂, the latter not quite typical. Females, June 14–July 22 (R.), at flowers of *Crepis runcinata*, *Polemonium* and *Iris;* also east of Lake George, June 18, fls. *Erysimum* (C.). The male June 16, fls. *Iris missourensis* (W. P. C.).

107. **Megachile vidua** *Smith* 1 ♂, July 18, fls. *Polemonium* (R.).

108. **Megachile montivaga** *Cress*. 1 ♀, June 19, fls. *Gilia* (R.); 1 ♂, July 1, fls. *Senecio* (R.).

109. **Psithyrus insularis** *Smith*. 2 ♀, June 15 (R.); June 16, fls. *Iris missouriensis* (C.).

110. **Bombus juxtus** *Cress*. 1 ♀, June 14, fls. *Iris missouriensis* (R.). Also a worker from Four Mile (on the Cripple Creek road) July 14 (Jean Bentley).

111. **Bombus dorsalis** *Cress*. 1 ♀, July 22, fls. *Capnoides* (R.).

112. **Bombus edwardsii** *Cress*. 1 ♀, June, fls. *Edwinia* (R.).

113. **Bombus dubius** *Cress*. 2 ♀, June 16, fls. *Iris missouriensis* (C.); July 15, at white *Carduus* flowers (Wheeler).

114. **Bombus appositus** *Cress*. June 16–July 13 (R.). One at fls. *Scrophularia*.

115. **Bombus huntii** *Greene*. ♀, June 15–16, fls. *Ribes longiflorum* (C.). Workers, July 11–22, fls. *Polemonium* (R.), *Pentstemon secundiflorus* (C.) and *Pedicularis* (R.).

The synonymy of this species will be explained elsewhere by Mr. Franklin.

116. **Bombus morrisoni** *Cress*. June 15 (R.).

117. **Bombus nevadensis** *Cress*. July 11, fls. *Polemonium* (R.).

118. **Bombus rufosuffusus** *Ckll*. June 16, fls. *Ribes longiflorum* (C.); Topaz Butte, June 17 (R.).

119. **Bombus iridis phaceliæ** *Ckll.* June 16, three at fls. *Iris missouriensis* (C.); July 18, fls. *Polemonium* (R.); July 22, fls. *Pedicularis* (R.). Following a suggestion from Mr. Franklin, I now incline to the view that *iridis* and *phaceliæ* are both forms of *B. rufocinctus* Cress.; *iridis* being the darkest, and *rufocinctus* the lightest, of the series. I have, however, no means of proving the correctness of this view, and I leave the settlement of the matter to Mr. Franklin.

At *Polemonium*, July 11, Mr. Rohwer took a dark ♀, which might almost be called *iridis* proper.

120. **Apis mellifera ligustica** *Spinola.* July 11–12, three at fls. *Polemonium* (R.). Honey-bees are not common at Florissant.

APPENDIX.

Mr. Rohwer returned to Florissant in August, and on the tenth of that month took seven species of bees from flowers of *Senecio.* These included *Agapostemon texanus* Cress. (2 ♀); *Melissodes confusa* Cress. (1 ♀); *Megachile montivaga* Cress. (1 ♂, a variety with the black hair as usual, but the light hair of head, thorax and abdomen all white instead of yellowish), and the following four species new to Florissant:—

121. **Megachile relativa** *Cress.* 2 ♀.

122. **Megachile manifesta** *Cress.* 1 ♀, 3 ♂. Mr. Rohwer notes that the eyes in life are "shining yellow-green" in the male, "gray-green, with black," in the female.

123. **Halictus** sp. 2 ♂. A rather large black species, not known to me in the male sex, but perhaps belonging to some described female.

124. **Andrena colletina**, sp. nov.

1 ♂. Length about or nearly 14 mm.; anterior wing a little over 8½; body black, with very abundant long light yellow hair; process of labrum strongly emarginate; facial quadrangle much broader than long; cheeks rounded, not angular; antennæ long; flagellum stout, only faintly brownish beneath; third antennal joint a little longer than fifth, not nearly as long as 4 + 5; front dull, but vertex shining; mesothorax dull and granular, as also is the scarcely defined area of metathorax; tegulæ dark; wings perfectly clear, the stigma and nervures light ferruginous; first r.n. joining second s.m. at or beyond middle; legs black, with hair like that of the body, all the tarsi ferruginous, the basal joint of middle and anterior ones a little stained with black; hair on inner side of basal joint of tarsi orange; spurs very pale reddish; abdomen rather long, with long hair, forming dense but suberect apical bands on segments 2 to 4, and to a less extent on 5; segments 4 and 5 with conspicuous black hair on the disc.

Close to *A. hirticincta* Provancher, ♂, but much larger, and differing also by the clear wings and black hair on abdomen above. The color of the pubescence is of the same tint of yellow. Also close to *A. mentzeliæ* Ckll. (which Mr. Titus has taken in Colorado—at Fort Collins) but distinguished from that also by the large size, quite clear wings, etc. On account of the wings and time of flight it cannot be the unknown ♂ of *A. ribesina*. *A. colletina* has a remarkable resemblance to a *Colletes*, and when I first saw it I supposed it to belong to that genus. Such resemblances have been noted before; *Andrena colletiformis* was originally described by Morawitz as *Colletes parvulus*.

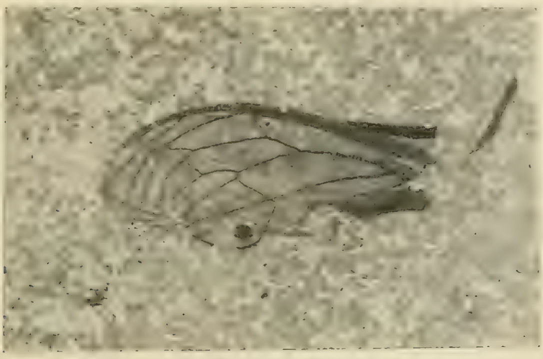
56,57,53L(78.8)

Article XXVI.—A FOSSIL CICADA FROM FLORISSANT, COLORADO.

By T. D. A. Cockerell.

Lithocicada gen. nov. (Cicadinæ.)

Anterior wing or elytron: radial cell not extending beyond middle of wing its apex less acutely pointed than in *Cicada;* first ulnar cell long and narrow, approximately its apical half separated from costal region by the intrusion of the first apical cell, which, as in *Tettigia*, is much longer than the second; second ulnar cell formed about as in *Tettigia*, except that its upper basal angle is united to the subcosta, and its lower basal angle is conspicuously less acute; third lunar shorter than in *Tettigia;* eight apical cells as usual, the second, third, fourth and sixth pointed basally, the fifth and seventh obliquely truncate basally, the fifth narrowed apically, the seventh large; medial cell surpassing radial, little more than its basal half contiguous with the radial, its apex obliquely truncate, with a single face instead of the three of *Cicada*, the seventh apical cell filling in all the space between the sixth and eighth; eighth apical cell large, inversely triangular; cubitus very narrow, its apex pointed or very narrowly obliquely truncate, not broadly truncate as in *Cicada*.



Wing of a fossil cicada (*Lithocicada perita Ckll.*)

Lithocicada perita, sp. nov.

Anterior wing about 23 mm. long, $10\frac{1}{2}$ broad, hyaline the veins dark brown; costa arched; radial cell 9 mm. long; medial $9\frac{3}{4}$ long; second ulnar $6\frac{2}{5}$ mm. long; third ulnar $7\frac{1}{3}$ mm. long, seventh apical $5\frac{3}{4}$ mm. long; eighth apical $2\frac{1}{2}$ mm. broad.

Hab.—Florissant, Colo., Station 13 (*W. P. Cockerell*, 1906). Type in Amer. Mus. Nat. Hist., and reverse at University of Colorado.

This insect will be readily recognized by the peculiar venation; especially the form of the cubital and adjacent cells. It cannot possibly be the anterior wing of *Cicada grandiosa* Scudder, being much too small. The latter species does not differ conspicuously from true *Cicada*, and may well remain in that genus.

56.4 (118 : 78.8)

Article XXVII. — THE FOSSIL MOLLUSCA OF FLORISSANT, COLORADO.

By T. D. A. Cockerell.

The Mollusca of the Florissant shales are neither numerous in species nor striking in appearance, and not unfrequently they are badly crushed. At Station 1, near the graveyard, and perhaps 150 feet above the level of the town, the individuals are very numerous, and are not crushed. The rock here has a more or less conchoidal fracture, and does not readily split into laminæ, but it is very hard, and the shells cannot be extracted from it. It was here that we found also vertebrate remains (teeth and bones), and while the material actually obtained was not especially varied or remarkable, it is likely that further digging would yield more important results. The best plant and insect beds are evidently those which have been buried under large quantities of material, and so subjected to great pressure, soon after deposition; but certainly the best Mollusca, and probably also vertebrates, may be expected in places where this has not been the case.

Leaving out certain fragmentary remains which may represent additional species, the known Mollusca of the Florissant shales number five species, one being terrestrial, the others aquatic. The operculate forms are entirely absent, but they would hardly be expected in a mountain lake.

The fossil land-shells of the Rocky Mountain region are few in number, so far as our present knowledge goes. An excellent summary was given by Dr. C. A. White in the Third Annual Report of the U. S. Geological Survey (1883), and not very much has been added since.[1]

ZONITIDÆ.

Omphalina *Rafinesque*.

Omphalina (?) **laminarum** sp. nov.

Fig. 1 *a* and *b*.

Diameter probably about 13 mm.; whorls with a smooth shining surface, with a weak radiate sculpture consisting of oblique shallow grooves separating flattened little-elevated ribs, four or five to a millimeter on last whorl; the ribs become stronger at some distance from the aperture, and are quite strong on penultimate whorl; last whorl convex, evenly rounded, with a diameter, seen from above, of about 3⅓ mm., the radial sculpture vanishing at about 2½ mm. from the suture; color as preserved grayish white.

---

[1] The most interesting additions are some species described from the Puerco Eocene of New Mexico, including a *Holospira* (*H. leidyi*) and a probable *Lysinoe* (*L. nacimientensis*). A few of the names given by Dr. White cannot be maintained. *Hyalina* (?) *occidentalis* M. & H., from the Judith River beds, is based on *Helix occidentalis* Meek & Hayden, 1857, not of Recluz, 1845: it takes the name *nebrascensis*, substituted by Meek & Hayden in 1861. *Columna teres* Meek & Hayden (*Bulimus teres* M. & H., 1836; *Clausilia teres* Meek 1866) is a homonym because of the snail from Crete described by Olivier as *Bulimus teres* in 1801, and now known as *Clausilia teres*. The American fossil (from the Fort Union beds) may be known as *Columna haydeniana:* the substitute-name *Clausilia occidentalis* Ckll., Science Gossip, 1888, p. 114, is not available because of an earlier *C. occidentalis* Bourgnignat.

Florissant; Station 14 (*Wilmatte P. Cockerell*). The plant *Planera longifolia* occurs on the same slab.

The specimen, showing only part of the last two whorls, gives the impression of a large Zonitoid shell, which from its size and general appearance should belong to *Omphalina* rather than *Vitrea*. It cannot be *Ashmunella*, on account of the smoothness of the surface and the character of the sculpture. It is like nothing now living in the Rocky Mountains; and its allies, if its affinities are correctly interpreted, live to-day principally in the mountains of Tennessee, North Carolina, etc., extending however from Texas and Florida even to Ohio and Ontario. There is a certain resemblance to *Pœcilozonites* of the Bermudas, especially in the contracted whorls.

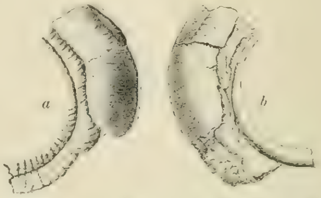


Fig. 1. *a*, *Omphalina* (?) *laminarum* sp. nov. showing portions of last two whorls of shell; *b*, impression of same. x 2½

LIMNÆIDÆ.

Planorbis *Geoffroy*.

Planorbis florissantensis. Ckll.

Fig. 2.

Very common. The type (*cf.* Nautilus, Jan. 1906, p. 100) was immature; the usual diameter is about 4½ mm., but a few have been found as large as nearly 7 mm. diameter. In these large specimens, the last whorl, near the aperture, has a diameter of about 2 mm.; the diameter of the shell without the last whorl is only 3½ mm. The periphery was rounded (not sharply keeled), especially in the young, but the shell was evidently very flat, and probably somewhat flexible, as it could endure pressure without much breaking. The oblique striæ on the last whorl are quite strong. One specimen is dark brown, which is probably the original color.

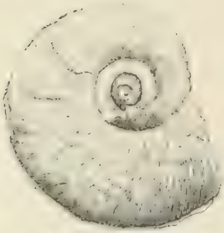


Fig. 2. *Planorbis florissantensis* sp. nov. x 7.

Collected by all the members of the expedition; Stations 1, 4, 11, 12, 13, 14. The shell was evidently nearly flat, after the manner of *P. vetustus* Meek and Hayden, not broadly rounded like *P. æqualis* White. The last whorl is broader than in *vetustus*, and not sharply keeled as in that species.

Lymnæa *Lamarck.*

Lymnæa sieverti sp. nov.

Fig. 3.

Long. 8 mm., lat. 4¼, with about five rounded whorls; length of aperture about 5 mm.; sutures impressed; sculpture weak; aperture contracted.

Florissant; Station 1 (*Sievert A. Rohwer*).!

This has the pointed spire of *L. meekii* Evans and Shumard, of the White River group, but it is much smaller, and has more rounded whorls. The elongate narrow aperture is more like that of *L. meekii* than of *L. shumardi* Meek and Hayden. The much more convex whorls distinguish it from *L. similis* Meek, and *L. vetusta* Meek, from the Bridger Eocene. There is quite a close resemblance to the living *L. humilis* Say, and *L. truncatula* Müller; in fact, if the shell were found living in Europe, it would doubtless be considered a variety of *truncatula*.

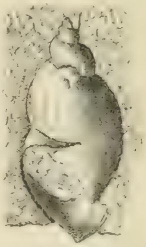


Fig. 3. *Lymnæa sieverti* sp. nov., showing interior of shell and outside of a portion near the mouth. x 4.

The specimen shows the interior of the shell, and the outside of a portion near the mouth. It is of course dextral, though from the manner of its preservation the aperture shows on the left side.

Lymnæa scudderi sp. nov.

Fig. 4. *a* and *b*

Length about 6 mm., breadth about 4, the spire short, about 1½ mm.; smooth and shining, without any strong sculpture; apex obtuse.

Florissant; Station 1 (*Rohwer*) and Station 14 (*W. P. Cockerell*); not uncommon.

Var. *a*. (Fig. 4*b*). Smaller and more slender; long. 5, lat. 3 mm.; length of aperture about 3 mm.; whorls only slightly convex. Station 12 (*W. P. Cockerell*). Station 12 is on the west side of Fossil Stump hill.

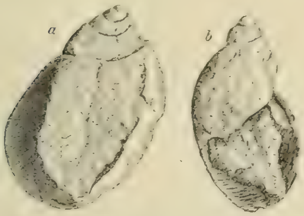


Fig. 4. *a*, *Lymnæa scudderii* sp nov. *b*, var. *a* of the same. x 4½.

A curious little shell, in some ways reminding one of a *Physa* rather than a *Lymnæa*, but dextral. The species is named after Mr. Scudder, who first indicated the presence of Mollusca in these beds.

Cyrenidæ.

Sphærium *Scopoli.*

Sphærium florissantense sp. nov.

Fig. 5.

Length 8¼, breadth 10 mm., with rounded outline like that of the European *S. corneum;* beaks not protruding or prominent; sculpture consisting of fine but distinct concentric striæ, 4 to 6 in about 150*μ*.

Florissant; Station 14 (*W. P. Cockerell*). Several specimens.

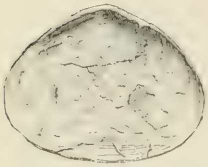


Fig. 5. *Sphærium florissantense* sp. nov. × 2½.

Very much like *S. rugosum* Meek, from the supposed Miocene of Nevada, but a little larger and without the prominent beaks. Smaller and strongly convex shells from Stations 1 (*Rohwer*) and 9 (*W. P. C.*) appear to be the young of this species.

59.9 (22.51.2)

Article XXVIII.—MAMMALS FROM THE ISLAND OF HAINAN, CHINA.

By J. A. Allen.

Plate LXIX.

Recently the Museum purchased a collection of mammals from Mr. Alan Owston of Yokohama, collected by his agents in the island of Hainan, China, in 1903 and 1904 (Dec. 20, 1902—July 4, 1904). The collection numbers 238 specimens, representing 31 species, and is noteworthy as being the first considerable collection of mammals received by any museum from Hainan.

In 1868 the island was visited by the late Robert Swinhoe, but he appears to have brought away very few specimens of mammals, and these were mainly flat skins, without skulls, purchased of the natives. He, however, published two papers on the mammals of Hainan, one on the 'Cervine Animals' (P. Z. S., 1869, pp. 652–660), and the other a general paper 'On the Mammals of Hainan' (P. Z. S., 1870, pp. 224–239), the two papers containing an enumeration of all the species of mammals he "saw or heard of during my [his] visit to that island." The species "actually seen or procured in whole or in part" by him numbered 24, with references to others, domestic and wild, taken from the 'Hainan Gazetteer.' His field notes on many of the species are extended and valuable, and he described a single species (*Lepus hainanus*) as new to science. These two papers constitute almost the entire sum of our published knowledge of the mammals of Hainan. Although quite a number of the species were provisionally determined without direct reference to specimens, or merely to imperfect skins, his records have gone into literature as the sole basis for the occurrence of a number of mainland species on the island of Hainan.

In 1892, Mr. Oldfield Thomas described the *Hylobates* of Hainan as *H. hainanus*, from a specimen received at the British Museum from Mr. W. T. Lay; this species was again referred to at length by Mr. R. I. Pocock, in 1905, his observations being based on a specimen living in the Gardens of the London Zoölogical Society. In 1892, Dr. A. B. Meyer referred to a specimen of *Semnopithecus* received at the Dresden Museum from Hainan, which he identified as *S. nemæus*.

The above-cited five papers comprise all the literature I have been able to find, after much search, relating directly to the mammalian fauna of Hainan, which has remained till now very little known.

The island of Hainan is separated from the mainland of southern China by the narrow Strait of Hainan, only some 15 to 20 miles wide. It is situated in N. Lat. 18°–20°, E. Long. 108° 30′–111°, and has a length of about 160 miles, with a breadth of about 90 miles, the longer axis running in a northeast-southwest direction. The area is given as 12,000 to 14,000 square miles. The surface is diversified, rising in the interior to mountains of 6,000 to 7,000 feet altitude, which protect the southern part from the monsoon; this part is subtropical, and is hence climatically quite different from the adjoining mainland of southern China.

The specimens constituting this collection consist of dry skins and skulls, the skulls being left inside the skins. The skins are well prepared, and are accompanied with data as to sex, date, and place of collection, and sometimes with measurements, but as these seem untrustworthy they have been discarded. The skulls prove to have been opened at the base for the removal of the brain, and are thus in nearly all cases more or less imperfect. Frequently, as among the bats and squirrels, each form is represented by a considerable series of specimens, in the case of the bats the young specimens having evidently been mistaken by the collectors for distinct species.

An attempt is here made to include all the species of mammals hitherto definitely recorded from the island of Hainan. They number 41 species and subspecies, of which 9 rest, with two exceptions, wholly on the observations recorded by Mr. Swinhoe, these species being the following:

Rusa unicolor equinus,
Panolia eldi platyceros,
Hystrix sp. incog
Mus norvegicus,
Felis macrocelis,
Lutra cinerea,
Ursus sp. incog.,
Myotis abramus,
Semnopithecus nemæus,[1]
Hylobates hainanus.[2]

One genus (*Tamiops*) and 13 species and subspecies are described as new in the present paper, namely:

Manis pusilla,
Atherurus hainanus,
Ratufa gigantea hainana,
Funambulus riudonensis,
Sciurus erythræus insularis,
Tamiops macclellandi hainanus,
Tamiops macclellandi riudoni.
Tupaia modesta,
Rhinolophus hainanus,
Hipposideros poutensis,
Scotophilus kuhlii insularis,
Scotophilus castaneus consobrinus,
Pipistrellus portensis.

---

[1] Included on the authority of Dr. A. B. Meyer.

[2] Later made known as a new species by Oldfield Thomas.

Regarding the localities at which the specimens were collected, unfortunately satisfactory information is at present lacking, as few of them are given on maps of the island, and thus far efforts to secure the desired information as to their location have failed. If received later it will be given in another connection.[1] The names of the localities are in many cases printed on the labels with a rubber stamp, and are thus clearly legible; in other cases they are so clearly written that every letter is distinct, and the intended orthography unquestionably determinable. The localities, in alphabetic order, with the number of specimens and date of collecting at each, are as follows:

Cheteriang, Jan. 5–29, 1904; 7 specimens.
Henron, May 10, 1904; 1 specimen.
Hoi-how, Dec. 25, 1902, and Jan. 4, 1903; 2 specimens.
Lei-Mui-Mon, Dec. 19, 1902, Jan. 14, 1903; 41 specimens.
Liudon, March 5 and May 8, 1903; 3 specimens.
Manrin, June 10, 1903, and June 11, 1904; 3 specimens.
Manrun, June 20, 1904; 1 specimen.
Mount Wuchi, April 6, 1903; 1 specimen.
Porten, July 2–4, 1904; 43 specimens.
Pouten, July 2–4, 1904; 55 specimens.

The specimens from Porten and Pouten are all bats; the names on the labels are in different handwriting for the two localities, and may refer to the same place, or may be merely names of different neighboring caves.

Rinsui, July 1 and 2, 1904; 33 specimens.
Rintoi, July 1 and 2, 1904; 28 specimens.

The specimens from Rinsui and Rintoi are also all bats, and these localities are doubtless close to Porten and Pouten, and may be merely names of caves, all situated within a small area. Nearly all the bats collected are labeled with one or the other of these four names.

Riudon, March 3–11, 1903; 9 specimens.
Taipin, June 1, 1905; 1 specimen.
Utoshi, March 20, 1903; 2 specimens.
Youboi, June 21, 1904; 1 specimen.

A few specimens are without definite localities, owing to the loss of labels.

The island of Hainan has evidently a rich mammal fauna, and doubtless future collections from the island will greatly extend the present list, which is very deficient in Muridæ.

1. **Manis pusilla** sp. nov.

PLATE LXIX, FIGS. 1–3.

Manis dalmanni SWINHOE (not of Sundevall), P. Z. S., 1870, pp. 236, 652 (the Hainan reference only).

---

[1] See below, p. 490.

Type, No. 26635, an old adult, Hainan, September, 1902.

Size very small; skull like that of *M. aurita* in general contour, but with long, pointed nasals and short postpalatal fossa.

Color of scales in adult uniform dark brown, in the young adults darker, blackish brown; ventral surface flesh-color, slightly clothed with very short, fine, light-colored bristly hair; nails yellowish white.

Rows of scales on median dorsal line in three specimens: head (type), 9, 10, 11; body (type), 21, 21, 19; tail (type), 18, 19, 15; total on median line (type), 48, 50, 45.

Total length (type), 670; head and body, 420; tail, 250; hind foot without claws, 56; longest fore claw, 21; longest hind claw, 43 mm.

Skull.—The general contour of the skull is nearly as in *M. aurita*, except that the rostral portion is as in *M. pentadactyla*, while the nasals are nearly as in *M. javanica*—much extended posteriorly and gradually narrowing to a point, instead of being short and more or less abruptly truncated on the posterior border. The orbit in the oldest specimen is closed by the malar bone. Below, the conspicuous feature of difference is the shortness of the postpalatal fossa, which is only .17 of the length of the skull, instead of .22 to .24 as in *M. aurita* and *M. javanica*, and .21 in *M. pentadactyla*. The pterygoids terminate opposite the middle of the auditai bullæ, instead of opposite their posterior border as in *M. aurita*. The ascending arm of the intermaxillary terminates just behind the emargination of the nasals.

The principal measurements of the type skull are as follows: Total length, 82; basal length, 76; greatest width of braincase, 57; least interorbital breadth, 27; length of intermaxillaries on palatal border, 7; length of maxillaries (palatal surface) on median line, 27; length of palatines (on median line), 20; length of pterygoids, 13; length of postpalatal fossa, 14; greatest length of frontals, 33; greatest length of parietals, 25; length of malar, 6; length of nasals, 30.5; greatest width of nasals (at fronto-maxillary suture), 12; least width of nasals (midway between frontals and intermaxillaries), 8 mm.

It has been generally customary since Anderson's revision of the group in 1878,[1] to recognize only three species of the genus *Manis* in the Oriental Region, *M. pentadactyla*, *M. aurita*, and *M. javanica*, with neither of which has the present species from Hainan any very close relationship. In size, coloration, number of rows of scales, and number of scales on the median line of the back, it is nearest to *M. aurita*, from which it differs mainly in considerably smaller size, and in important cranial characters, as especially in the form of the nasal bones and postpalatal fossa. In *M. aurita* the nasals are short, abruptly truncated posteriorly, and of nearly uniform width throughout; in *M. pusilla* they are relatively much longer, widest at the fronto-maxillary suture, from which point they taper evenly posteriorly and terminate in a point; in front of the fronto-maxillary suture they are much narrowed, expanding again apically. In other words, they are the nasals of *M. javanica* on a skull essentially of the type of *M. aurita*. In *M. aurita*, however, the pterygoids are long, about as long as the palatines, and enclose a long postpalatal fossa, as is the case also in *M. pentadactyla* and *M. javanica;* in *M. pusilla* the pterygoids are short, or only about half as long as the palatines, with a correspondingly short postpalatal fossa. These differential features are not such as could be accounted for by any probable amount of individual variation in either *M. aurita* or *M. javanica*, its nearest geographical allies.

---

[1] Zoöl. and Anatom. Researches, Yunnan Expedition, 1878, pp. 341–353, pl. xxiv.

The species is based upon three specimens, which agree in all essential characters, though differing considerably in age. The older specimen is without any more definite locality than "Hainan, China," but as it is a very old individual, with the skull perfect and heavily ossified, it has been taken for the type in preference to the others, which are younger, with the bones of the skull less dense and the sutures more open, collected as follows: a young adult, Manrin, June 11, 1904; a still younger specimen, Manrin, June 10, 1903.

Mr. Swinhoe (P. Z. S., 1870, p. 236) "procured the skins of an adult and of a young Scaly Anteater at Hainan," which, he says, "have much in common with the South-China species." He referred the specimens to *Manis dalmanni* Sundevall, which is now currently recognized as a synonym of *M. aurita.*

2. **Rusa unicolor equinus** (*Cuvier*).

Hainan Sambur, Swinhoe, P. Z. S., 1869, pp. 656–660, figs. 1–3, antlers. (Referred to *Cervus equinus* Cuv. in text, p. 659.)

Cervus hippelaphus Swinhoe, P. Z. S., 1870, p. 647, in text.

Not represented in the present collection.

Swinhoe says: "The Sambur is an abundant species on the jungly mountains of the southern half of Hainan; and large numbers are yearly slaughtered by the independent *Le* tribes, and the skins and horns bartered to the Chinese" (*l. c.*, p. 659). Mr. Swinhoe obtained the skins of a male and a female, both adult, in winter coat, and three pairs of antlers of animals from two to five years old. These specimens are carefully described and the antlers are figured. The species was at first believed "to be identical with the *Cervus equinus* Cuv., of Sumatra and Borneo," but a year later (*op. cit.*, 1870, p. 647) he refers to it as "*C. hippelaphus.*" Lydekker, in his 'Deer of All Lands' (p. 153), includes the Hainan Sambar under his *Cervus unicolor equinus*, "as suggested by Mr. W. L. Sclater."

The Hainan race of the Sambar apparently requires further examination in order to fully settle its relationships. Swinhoe states that it "approaches the *C. rusa* of Java in the whiteness of the under parts," in which respect it is quite unlike either the Indian Sambar or the Malayan Sambar. Doubtless a good series of specimens would show it to be readily separable as an insular race from either of the mainland forms.

3. **Panolia eldi platyceros** *Gray.*

Panolia eldi Swinhoe, P. Z. S., 1869, pp. 653–656, figs. 1–5, antlers.

"*Panolia frontalis* (Hodgson) *Cervus eldi* (Guthrie)" Swinhoe, P. Z. S., 1870, p. 644 (in text).

Panolia platyceros Blyth (in Swinhoe), P. Z. S., 1869, p. 656, in text.

Not represented in the present collection.

Mr. Swinhoe obtained skins of a female and a fawn, and five pairs of antlers and two odd ones, which are here referred without question to *Cervus eldi* Guthrie. He cites Mr. Blyth as being of the opinion that "the Hainan *Panolia* is identical with that of Siam (*P. platyceros* of Gray), the distinction from the other, or western form, being apparent as the horns increase in size." Lydekker (Deer of All Lands, 1898, p. 201) places the Hainan form under the subspecies *platyceros*

4. **Cervulus muntjac** (*Zimmermann*).

Cervulus vaginalis Swinhoe, P. Z. S., 1869, p. 652; *ibid.*, 1870, p. 644; *ibid.*, 1872, p. 813, in text.

One specimen, skin and skull of a young female, Taipin, Hainan, June 1, 1905.

The only original authority for the occurrence of the Muntjac in Hainan appears to be Swinhoe's record, as given above, which has been cited also by various later authors. Swinhoe states that he obtained a number of imperfect skins and two pairs of antlers, both from rather young animals. From a study of this material he was convinced that the Hainan species was referable to *C. vaginalis* (Boddaert=*muntjac* Zimm.) "and not to the *C. reevesi* of China as one would rather have expected it to be." He also states that Mr. Blyth agrees with him in this identification. Later authors, doubtless on this basis, have commonly assigned Hainan to the range of *C. muntjac.*

5. **Lepus hainanus** *Swinhoe.*

Lepus hainanus Swinhoe, P. Z. S., 1870, pp. 233, 639, pl. xviii, text-figs 1–4; Forsyth-Major, Trans. Linn. Soc. Lond. (2), Zoöl., VII, pp. 466–468 (passim), fig. xix, upper incisors.

Two specimens: a skin and skull of an old animal, Jan. 10, 1903, without indication of sex or definite locality; a young female, skin and skull, Liudon, May 18, 1903.

A species of *Lepus* was described by Swinhoe from a single specimen taken in the neighborhood of the capital city of Hainan. The description is detailed, and there is a colored plate of the animal and four text figures illustrating the skull. The colored plate agrees rather poorly with the description and with the present specimens, being much too rufous. The description of the coloration and external characters agrees satisfactorily, except as to size, the measurements being too small. The total length is given as 14 inches, while the collector's labels on the present specimens give the length in each as "16⅘" inches. The length of the skull as given by Swinhoe is 10 mm. less than in the older of the specimens, with the other measurements proportionally less. Judging by the distinctness of the sutures in Swinhoe's figures of the skull, his specimen was probably rather young, which may in part account for the difference in size. But there are other discrepancies, not so easily explained, in respect to the characters of the skull. Swinhoe says: "Incisive opening above palate narrower at base." This is hard to interpret, as a palatal view of the skull is not included in the four text figures. "Posterior edge of palate with rounded nasal spine, the same part being smoothly convex in *L. sinensis*." In the present specimens the posterior border of the palate is smoothly transverse, with a short, pointed spine on the *anterior* border. "Anterior upper incisors without the deep groove which characterizes these teeth in the genus *Lepus*, but marked by several narrow indistinct ridges." Fig. 2 in the text appears to represent the incisors as evenly convex, with several slight striæ. In the older of my specimens the upper incisors are strongly ridged or ribbed on the inner edge, with the rest of the surface smooth. The antero-posterior thickness of the tooth at the cutting edge is thus about one third greater on the inner border than elsewhere. In the younger specimen, in which the teeth are much less worn, the inner third of each tooth is occupied by a deep sulcus, divided in the middle by a slight, very narrow ridge. The incisors are thus very unlike those described and figured by Swinhoe.

Swinhoe's measurements (his "breadth from molar to molar" should read, of course, malar to malar) of the skull are intermediate between those of the two before me, one of which is very old and the other not fully adult, showing Swinhoe's specimen to have been middle-aged. Reducing his measurements to millimeters, the two skulls (Am. Mus. No. 26640, old, and Swinhoe's) compare as follows: Total length, 80 and 72; zygomatic breadth, 38.5 and 36.8; interorbital breadth, 18 and 15.5; width of braincase, 27 and 25; front of incisors to first molariform tooth, 25 and 21.6; height of skull with lower jaw, 51 and 45.7 mm. The young skull measures considerably less than the Swinhoe skull.

The discrepancies between Swinhoe's description of *Lepus hainanus* and the present specimens may be in part due to faults of description, yet it is hard to believe that he could have overlooked the deep groove on the inner third of the incisors, although he may have written posterior for anterior in describing the palatal spine. In the present specimens there is a broad white eyering, which extends forward as a broad band nearly to the nose. Swinhoe says: "Anterior edge of eyelids and a patch in front of it white." The plate, however, shows a distinct, rather broad light eyering. There may be, of course, two small species of *Lepus* on the island of Hainan, but in the present connection it seems better to recognize but one.

Since writing the above I have examined Dr. C. J. Forsyth-Major's memoir (*l. c.*) 'On Fossil and Recent Lagomorpha,' where he figures (text fig. xix, p. 468) the anterior end of the upper incisors of *Lepus hainanus* (doubtless from the type specimen, although it is not so stated). The enamel pattern as here shown agrees perfectly with that of the adult specimen here described; which seems to show conclusively that the apparent discrepancies between my specimens and Swinhoe's description of *L. hainanus* are due to the inaccuracy of the description.

Atherurus hainanus sp. nov.

Type, and only specimen, No. 26641, old adult (sex?), Hainan, September, 1902.

Above brown, blackish on the back, lighter, dusky brown on the head, the flanks varied dark brown and whitish; underparts light brown much varied with whitish; upper surface of feet and limbs brown, the latter proximally lighter and tinged with lavender gray. The spines over the mid-dorsal region are apically blackish, the basal half lighter, gradually passing into whitish at extreme base; some of the shorter ones are tipped with white, but only a few of these are visible at the surface. On the sides of the body the exposed portion of a few of the longest spines is wholly dusky, but the greater number are white with a broad indistinctly defined dusky band of variable extent on different spines. On the ventral surface the prevailing pale brown color is due to the tips of the spines, the basal three fourths or more being whitish or white.

The spines are flat on the lower surface and strongly grooved on the upper, and very sharp pointed; the transverse diameter is much greater than the antero-posterior. On the nape the spines are about 20–25 mm. long, increasing in length on the more posterior parts of the mid-dorsal region to about 40 mm., and on the lumbar region from 45 to 55 mm. Mixed sparsely with the flattened spines are a few slender bristly spines, round and tapering, usually dusky or broadly banded with dusky proximally and whitish for their apical third; the longest, situated on the posterior third of the body, have a length of 70 to 90 mm. Between the spines is a very sparse coat of fine yellowish white hair, visible only on separating the spines.

The muzzle is wholly covered with short hair, and a broad eyering is similarly clothed; soles and palms naked; the nails on the fore feet are short, thick, and subconical, 5–7 mm. long; those on the hind feet are of similar form, but of course stouter. The tail, except at the extreme base, is scaly, the middle portion nearly naked, the only covering being short, thick blackish spines, 5 to 15 mm. in length, interspersed with longer bristly hairs, there being usually either a bristle or a spine at the apical border of each scale. These become longer and assume the character of thick spiny bristles over the subapical fifth of the tail, while on the apical fifth they are replaced by flattened foliaceous bristles, nearly 2 mm. wide and 50 to 60 mm. long. The ears are high and narrow, rounded on the antero-upper border, nearly straight on the posterior border, with a distinct emargination at the base.

Measurements. — The following external measurements are from a well-made dry skin: Total length, 520; head and body, 381; tail, 139; hind foot, 64; ear from notch, 30; width of ear, 18 mm.

Skull. — The skull in general form is quite similar to that of *E. macroura*, but the malar has less anterior extension. The palatal fossa is nearly v-shaped and extends forward to the middle of the penultimate molar. The present skull is that of an old individual, of unknown sex, with the teeth much worn. It measures, condylo-basal length, 89; basal length, 82; basilar length, 74; palatal length, 45; palatilar length, 37; least interorbital breadth, 27; greatest breadth (at posterior end of zygomata), 45; mastoid breadth, 32.3; length of nasals, 27; width of nasals anteriorly, 20.5, posteriorly, 11; length of upper diastema, 25.6; length of upper toothrow (crown surface), 15; length of mandible (front border of symphasis to posterior border of condyle), 55; height of lower jaw at condyle, 22; length of lower toothrow, 16.5 mm.

This species is nearly related to *Atherurus macrourus* (Linn.) of the neighboring mainland (Malay Peninsula, Cochin China, Burma, Assam), but is smaller and darker in color, with shorter spines and a much shorter tail. It more nearly agrees in size with the insular *Atherurus zygomaticus* Miller, from Pulo Aor, from which it differs in the narrower zygoma and larger lachrymal.

The only previous record I have met with of a porcupine in Hainan is Swinhoe's statement (P. Z. S., 1870, pp. 233, 638) that one of his party "picked up a Porcupine's quill in the jungle at Nychow (S. Hainan)," which was evidently a quill of some speciesof *Hystrix* and not of an *Atherura.* He referred it first to *Hystrix hodgsoni* Gray (*l. c.*, p. 233), and later (*l. c.*, p. 638) to his *H. subcristata.* It is on this record that Hainan is still included within the range of *H. subcristata.*

7. **Hystrix** sp.

Hystrix hodgsoni Swinhoe, P. Z. S., 1870, p. 233.
Hystrix subcristatus Swinhoe, P. Z. S., 1870, p. 638.

It is inferred that a species of true *Hystrix* occurs in Hainan, but the evidence is not satisfactory, resting on a porcupine quill found at Nychow by Mr. Swinhoe, and by him referred as indicated above.

8. **Mus** sp.

One specimen, about half grown, and hence not readily determinable, from Riudon, March, 1903.

9. **Mus norvegicus** *Erxleben*

Mus decumanus Swinhoe, P. Z. S., 1870, 233

Mr. Swinhoe says: "Common at Kiungchow city, and in all the large towns visited." Not represented in the present collection.

10. **Ratufa gigantea hainana** subsp. nov.

Type and only specimen, No. 26638, ♂ ad., Cheteriang, Hainan, without date or external measurements.

Whole upper parts, outside of limbs, and the tail uniform intense black; ventral surface and inside of limbs rusty yellow, the basal half of the pelage over the chest and belly brownish black, showing more or less at the surface over the central part of the abdominal area; a broad black cheek stripe, and two small spots of black on the chin. Ears tufted Hind foot, 80, with claws 85 mm. Skull, total length, 74; basilar length, 57; zygomatic breadth, 46; across postorbital processes, 42.5; interorbital breadth, 29; length of nasals, 25 mm.

The Hainan *Ratufa* agrees more nearly in color and size with *R. gigantea* than with *R. bicolor.* It has the uniform intense black color above of *R. gigantea* with, in the present specimen, the under parts orange yellow, the hair basally blackish over a broad central area of the ventral surface. It is about intermediate in size between *gigantea* and *bicolor*, with, however, relatively much longer nasals.

There appears to be no previous record of this genus from Hainan.

11. **Funambulus riudonensis** sp. nov.

Type, No. 26651, ♀ ad., Riudon, island of Hainan, March 11, 1903.

Pelage of upper parts short and soft, mixed with many long, bristly, shining black hairs; of under parts soft and more or less woolly.

Dorsal region, from occiput to base of tail, and flanks dark olivaceous brown, without a median stripe; the hairs individually are black, narrowly annulated near the middle with yellow, and with a short yellow tip, mixed with a few hairs black-tipped or wholly black; whole upper aspect of head reddish chestnut finely punctated with black; sides of the head, from the nose posteriorly, uniform deep chestnut red; mystacial bristles deep black; ventral surface superficially white or faintly yellowish white, with the basal portion of the fur dusky: sides of neck, shoulders, and outer surface of fore limbs reddish, varied slightly with black-tipped hairs; front of thighs and inside of hind limbs deep reddish chestnut, the outside reddish brown varied with black-tipped hairs; feet dark tinged with reddish brown, the hind feet a little darker and redder than the front feet; ears thinly clothed, dark brown tinged slightly with reddish, with a large fluffy spot of soft white fur at the outer base; tail above blackish, the hairs tipped and annulated basally with dull white; lower surface of tail deep chestnut, bordered narrowly with black and slightly fringed with white. The red on the sides of the head and neck, the large deep red area on the front of the thighs, and the red under surface of the tail are the conspicuous features of the coloration, to which may be added the red head in striking contrast with the dark olive brown back.

Measurements (from a well-prepared skin).—Total length, 305; head and body, 170; tail vertebræ, 135; tail to end of hairs, 180; hind foot without claws, 40, with claws, 45; ear from crown, 15 mm. The skull is long and narrow, the rostral portion greatly elongated and attenuated, with very long, narrow nasals. It is, however, decidedly broader and less elongated than in the extreme development reached in this respect in *Rhinosciurus laticaudatus*. Length (occiput imperfect) from incisors to posterior border of audital bullæ, 45; zygomatic breadth, 30; interorbital breadth, 16; greatest width of braincase, 24 length of nasals, 19; width of nasals posteriorly, 6, anteriorly, 6.5; palatal length, 30; palatilar length, 23.5; maxillary toothrow, 10; diastema, 25; mandibular ramus, front border of symphysis to tip of condyle, 24; height at coronoids 12.6; toothrow, 10 mm.

Represented by 5 specimens, all taken at Riudon, March 3, 10, and 11, 1903, and quite uniform in coloration.

This species seems to find a near ally in *Funambulus pyrrhomerus* (Thomas), from Ichang, Yang-tse-kiang, from which, however, it differs in the sides of the head being rich red, and in the red of the tail extending over the anal region. The postauricular patch of soft fur is clear white instead of yellow. In size, in general coloration, and in the form of the skull the two species are quite similar.

12. **Sciurus erythræus insularis** subsp. nov.

Sciurus castaneiventris SWINHOE, P. Z. S., 1870, p. 231.

Type, No. 26609, ♀ ad., Lei-Mui-Mon, Hainan, Jan. 5, 1903.

Above olivaceous gray, the hairs individually dusky plumbeous at extreme base, then ringed alternately with narrow bands of yellowish olive and broad bands of black, about three of each, the tip of the hair being usually yellowish but frequently black; outside of limbs like the back, becoming darker on the upper surface of the feet, the hind feet often blackish; whole head like the back, with the sides of nose, cheeks, chin, and throat rather lighter and grayer; ventral surface, from the chest to the base of the tail, and inside of limbs, vinaceous rufous, mixed with gray on the foreneck; posterior surface of ears yellowish, faintly tinged with rusty on the margin, and rusty yellow on the inner surface; tail above for the basal half like the back, apical half blackish strongly washed with yellowish white; the hairs individually, for the basal two-thirds of the tail, are olivaceous yellow ringed with black, the black annulations becoming broader from the base of the hairs toward the tip; on the apical third of the tail the yellowish annulations are limited to the basal half of the hairs, the subapical portion being black broadly tipped with yellowish white; lower surface of tail olivaceous yellow (a little more yellowish than the back), finely grizzled with black, bordered laterally on the apical half by a band of black and an outer fringe of yellowish white, the black band widening gradually towards the tip of the tail, where the hairs become wholly black to the base, with conspicuous yellowish white tips.

Measurements (of type from skin).—Total length, 450; head and body, 250; tail vertebræ, 200; tail to end of hairs, 215; hind foot without claws, 43, with claws, 47 mm.

Skull.—Total length, 53 (occipital region imperfect); zygomatic breadth, 31; interorbital breadth, 19; mastoid breadth, 22; length of nasals, 17; length of upper toothrow, 10; diastema, 11.5 mm.

Twenty-six specimens, 16 males and 10 females, all adult, collected as follows: Lei-Mui-Mon, 24 specimens, Dec. 20 to Jan. 12; Liudon, 1 specimen, March 5; Utoshi, 1 specimen, March 20.

There is much variation in the extension anteriorly of the red of the under parts; in a few specimens it wholly ceases at the upper border of the breast, the whole foreneck, throat, and chin being gray; in a few others it extends to the throat, wholly unmixed with gray; but in by far the greater part of the specimens the foreneck and throat are gray more or less tinged or suffused with red. The anal region is gray, and in about one specimen in three the gray extends forward as a very narrow median line to the chest. The apical half of the tail is black and whitish (often nearly clear white); in about half the specimens the color is a patternless grizzle, but in at least a third of them the outer half of the tail is distinctly annulated black and white, and a strong tendency to regular bars is obvious, when the hairs are in place, in most of the specimens of the series.

The tendency to a narrow gray mesial ventral line recalls *Sciurus gordoni* Anderson, from Upper Burma, and *S. thaiwanensis* Bonhote (and subspecies) of Formosa in which latter sometimes gray and sometimes red prevails on the underparts. Swinhoe refers (*l. c.*) to a Hainan specimen in which the red of the underparts is divided by a broad band of gray.

According to Mr. Swinhoe, this squirrel is a common species in Hainan, both in the interior and along the coast.

In Mr. Bonhote's paper 'On the Squirrels of the *Sciurus erythræus* Group' (Ann. and Mag. Nat. Hist. (7), VI, Feb., 1901, pp. 163–167), the island of Hainan is not mentioned in the list of localities cited under the various species and subspecies of the group, nor is there any reference to Swinhoe's Hainan specimens, which are hence perhaps not now in the collection of the British Museum, although two Hainan specimens were commented upon by Anderson (Anatom. and Zoöl. Researches, 1878, p. 240, under *Sciurus castaneoventris*), which appear to be the specimens described by Swinhoe.

Tamiops gen. nov.

PLATE LXIX, FIGS 1–4.

Type, *Sciurus macclellandi* Horsfield (more strictly, *Tamiops macclellandi hainanus* subsp. nov.).

In southern India and southern China, from Assam east to Foochow and Formosa, and south to the Malay Peninsula and Hainan, is found a group of small, semiterrestrial, slender-tailed squirrels which externally, including the color-pattern, seem hardly distinguishable from the little striped ground squirrels of northern Asia and North America constituting the genus *Eutamias*. The broad, short-nosed skull, however, is distinctly of the sciurine type, and not like that of *Eutamias* and the other true ground squirrels; but the teeth prove to be quite different from those of typical *Sciurus* (type, *S. vulgaris* Linn.). It was therefore a matter of surprise in working up the Hainan representatives of the *S. macclellandi* group to find that the latest writers on the group still refer them to *Sciurus*, while recognizing such Old World sciurine genera as *Ratufa*, *Funambulus*, *Rhinosciurus*, etc. It has seemed proper, therefore, to recognize this well-marked group as of generic (or at least subgeneric) value, for which I propose the name *Tamiops*, in recognition of its external resemblance to *Tamias*, and more especially to *Eutamias*, with the following characters:

In small size, slender, narrow tail, and pattern of coloration, including not only the five dorsal stripes but in the details of the head-pattern, like *Eutamias;* general form of the skull sciurine—short and broad with short rostrum—like *Sciurus*, but with the molariform teeth structurally different. In *S. vulgaris* the outer border of p^2, m^1, and m^2, is crenulated, there being in addition to the two main cusps a very low cusp between them and a fourth anterior cusp slightly larger than the very small median one, resulting in what may be termed a crenulated border. In *Tamiops* m^1 and m^2 have only the two main cusps, without the smaller median and anterior cusplets. In *Tamiops* p^2 has an additional anterior small cusp, making three on the outer border, while in *Sciurus* there is in addition to these three a minute cusplet between the posterior two. M^3 is essentially the same in both groups. In the lower jaw in *Sciurus* there is on the exterior border of the crown an incipient cusp between the two main cusps of each tooth of the series, which is entirely lacking in *Tamiops;* on the inner border the pattern is essentially similar in each. (See Pl. LXIX, Figs. 4–7.)

The characters of the teeth separate the group from *Sciurus* proper and the combination of characters here specified sufficiently characterize it as a well-marked special group of the Sciuridæ.

13. **Tamiops macclellandi hainanus** subsp. nov.

Sciurus m'clellandi Swinhoe, P. Z. S., 1870, p. 232.

Sciurus macclellandi Bonhote, Ann. and Mag. Nat. Hist. (7), V, Jan., 1890, p. 52 (part).

Type, No. 26664, ♀ ad., Lei-Mui-Mon, in the mountains of central Hainan, Dec. 31, 1902.

Top of head, nape, sides of neck, shoulders, flanks, and outside of limbs yellowish gray minutely flecked with black, the hairs individually nearly black at base, then annulated narrowly with pale yellow and black and generally tipped with yellow but some of them with black; median dorsal stripe black, of variable extent, but usually extending from the shoulders to the base of the tail; on either side of this a shorter light, yellowish gray stripe, of nearly the same color as the nape and shoulders; exterior to this a darker, pale reddish brown stripe; and exterior to this an outer pale yellowish stripe, varying in different specimens from pale buff to deep buff; a short median black stripe on the nose, which soon divides, a branch passing on either side to the anterior canthus of the eye, and thence curving down below the buffy eyering runs to the base of the ear; a broader deep buff band begins at the nose, adjoins and follows the black stripe to the base of the ear and thence along the side of the neck to the shoulder; an indistinct blackish stripe below this on the side of the nose (enclosing the whiskers) descends and runs posteriorly along the lower edge of the malar region as far as a point opposite and considerably below the ear; these stripes, in specimens with disarranged fur, appear more or less indistinct, giving to the sides of the face a dingy yellowish gray effect; eyering complete, broad, deep buff; ears internally buffy yellow, externally heavily clothed with soft and fluffy black fur, broadly tipped with pure white; the rim of the ear is thus conspicuously edged with black relieved against white, the latter forming a distinct white ear tuft; whole ventral surface and inside of limbs yellowish white, the basal portion of the fur dusky; tail above mixed black and yellowish white, the hairs at extreme base narrowly ringed with black, then more broadly annulated with reddish yellow and black and tipped broadly with yellowish white; tail below with a broad median area of reddish yellow mixed slightly with black, with a narrow border of black and an outer conspicuous fringe of pale yellow; feet grizzled yellowish gray, more yellowish on the toes.

The skulls are unfortunately too imperfect to furnish satisfactory measurements. Type skull, front of nasals to parieto-occipital suture, 33; least interorbital breadth, 12; breadth of braincase, 17; length of nasals, 9; width anteriorly, 5; posteriorly, 3; palatal length, 18; palatilar length, 14; maxillary toothrow, 5.7 mm.

Twelve specimens, all from Lei-Mui-Mon, Dec. 19, 1902, to Jan. 14, 1903. They are for the most part very uniform in coloration. The mid-dorsal black stripe varies in length in different specimens, beginning at the shoulders and running with more or less distinctness to the base of the tail, although in some hardly traceable beyond the hips. The outer light stripe varies from pale to deep rich buff, and runs generally only from the shoulders to the hips; in one or two specimens it is indistinctly traceable across the shoulders to the yellow neck stripe.

Mr. Swinhoe adds to his detailed description of Hainan specimens: ". . . this little Striped Squirrel is found in Formosa, the Ting-chow mountains of Fokien, and in Hainan. In the latter island I first detected it in the forests of the interior; but I observed it later in most wooded places, especially where the Areca- and Cocoanut occurred. It runs with great agility along the ground and up the trunks of trees, but it descends trees slowly and awkwardly. It is, however, quite an arboreal species."

14. **Tamiops macclellandi riudoni** subsp. nov.

Type, No. 26672, ♂ ad., Riudon, (east of Lei-Mui-Mon, and at much lower elevation) Hainan, March 5, 1903.

Similar to *Tamiops macclellandi hainanus*, but larger and much brighter colored. The dorsal stripes and head markings are similar, but the color above is reddish brown instead of yellowish gray, the whole dorsal region being suffused with reddish, except the median black stripe and the outermost pale stripe; ventral surface strongly ochraceous, brightest on the chin, throat, breast, and anal region, instead of pale yellowish white.

Skull (imperfect) —Length from front border of nasals to parieto-occipital suture, 35; least interorbital breadth 13; breadth, of braincase, 17.5; length of nasals, 10; width anteriorly, 6, posteriorly, 3.2; palatal length, 19.5; palatilar length, 15; maxillary toothrow, 6 mm.

Three specimens, all from Riudon, March 5–9, 1903. All have strong ochraceous suffusion below, especially strong on the throat, breast, and anal region. In all the general rufescent shade above, and the more grayish cast of the inner light dorsal stripes, are marked in comparison with the yellowish cast in *hainanus*. It seems to approach in general characters *T. c. formosanus* (Bonhote) from north Formosa.

15. **Felis chinensis** *Gray.*

Three specimens,—a male, Cheteriang, Jan. 20, 1904; a young kitten, Mount Wuchi, April 6, 1903; the other is without definite locality or indication of sex, owing to loss of the collector's label. Both the adults are in good condition, including the skulls.

The two specimens are alike in the general pattern of markings but differ considerably in color. In the male specimen (No. 26602), there is much black in the dorsal area, the black stripes on the head, nape, and shoulders being not only well-defined, but the whole median area from the shoulders to the base of the tail is chiefly black, consisting of irregular narrow stripes and small spots of black set in a general ground color of reddish brown. The sides are paler, with the ground color pale fulvous gray mottled with small spots of black encircled with rusty brown; at the lower edge of the flanks the ground color passes into whitish, and into clear white on the ventral surface, blotched with large spots of mixed brown and black on the flanks and blackish on the median area below.

The other specimen (No. 26601) is similar on the head and nape, but from the hind neck posteriorly the amount of black is inconspicuous, consisting mainly of a grizzle of black hairs in place of stripes and distinct spots, mixed with reddish brown. The gray spots and streaks on the sides are lighter clearer gray, and the intervening spaces are dark reddish brown varied with scattered flecks of blackish. The ventral surface, the feet, tail, head, and throat markings are similar in both. The feet are yellowish finely mottled with blackish. The median third of the under surface of the tail is yellowish gray; the sides and dorsal surface clearer gray with narrow half rings of black, wider than the gray interspaces, and a blackish tip.

The young kitten was apparently only a few days old when taken, and is in the soft woolly first pelage. The general color above is dull rusty brown, strongly streaked with blackish; below grayish white, barred on the breast and spotted on the belly with blackish brown.

The adult skulls measure, respectively, as follows: Total length, 91, 87.5; basal length, 78, 75; basilar length, 76, 73; palatal length, 35, 34; zygomatic breadth, 60, 59; greatest width of braincase, 41.3, 40; least distance between carnassials, 22, 22; length of carnassial, 10, 10 mm.

These specimens seem clearly referable to *F. chinensis*, as described by Swinhoe (P. Z. S., 1870, p. 629), Milne-Edwards (Rech. Mamm., 1868–1874, pp. 216–220, pl. xxi^{b}, fig. 2), and Bonhote (Ann. and Mag. Nat. Hist. (7), XI, April, 1903, p. 376), and probably of Gray (Charlsworth's Mag. Nat. Hist., I, 1837, 577). *Felis ricketti* Bonhote differs in larger size and in the ground color of the upperparts. *F. scripta* Milne-Edwards is also a near ally, but differs somewhat in markings.

16. **Felis macrocelis** *Horsfield.*

Felis macrocelis Swinhoe, P. Z. S., 1870, p. 228.

Mr. Swinhoe (*l. c.*) states that he was shown a skin of this species in the mountains of Hainan said to have been "procured in that neighborhood." He adds: "I was told that the true Leopard also occurred in Hainan."

17. **Viverra zibetha** *Linnæus.*

Viverra zibetha SWINHOE, P. Z. S., 1870, pp. 227, 630.

One specimen, skin and skull, an adult female, Cheteriang, Hainan.

Mr. Swinhoe procured two flat skins at Ling-mun, central Hainan, and its currently recognized occurrence in Hainan appears to have heretofore been based on this record.

18. **Viverricula malaccensis** (*Gmelin*).

Viverricula malaccensis SWINHOE, P. Z. S., 1870, pp. 227, 630.

Two specimens, skins and skulls: an adult male, Hoi-how, Dec. 24, 1902, and an adult female, Cheteriang, Jan. 5, 1905.

Mr. Swinhoe obtained a skin of this animal at Ling-mun, central Hainan, which forms the only previous reference I have seen to the occurrence of this species in Hainan.

19. **Paguma larvata** (*Ham. Smith*).

One specimen, skin and skull, adult female, Cheteriang, Hainan. Jan. 10, 1904.

Apparently not previously recorded from Hainan.

20. **Herpestes griseus** (*E. Geoffroy*).

Herpestes, sp. SWINHOE, P. Z. S., 1870, p. 228.

Two specimens, an old female, Liudon, March 5, 1903, and a young male, without definite locality, May 10, 1905. The young male still retains the milk dentition.

Mr. Swinhoe states that one evening at Kiungchow he "observed a Mungoose running along a bank outside the city wall," and later saw "a skin of apparently the same species hanging up in a garden at Schuyweisze (central Hainan) to serve as a scarecrow," but obtained no specimens and was therefore unable to identify the species.

The two specimens in the present collection are apparently much redder than the ordinary type of *griseus*, the whole front and sides of the head being strongly suffused with rufous chestnut (the younger specimen more than the older one), as are also the feet.

21. **Lutra** sp.

Lutra chinensis SWINHOE, P. Z. S., 1870, pp. 228, 229.

One specimen, very young, without definite locality, August 4, 1905

This specimen is only about one-fourth grown, retaining the milk dentition, and is thus too young for satisfactory determination. It is a bare-nosed otter with large claws, and is probably referable to *Lutra lutra* (Linn.).

Its previous Hainan record is the "skin of an animal about half grown," obtained by Swinhoe (*l. c.*).

22. **Lutra cinerea** *Illiger.*

Aonyx leptonyx Swinhoe, P. Z. S., 1870, p. 229.

Mr. Swinhoe obtained three skins, without skulls, of this species, which he described at length. This seems to be at present the only record of this species for Hainan.

23. **Helictis moschata** *Gray.*

Helictis moschata Swinhoe, P. Z. S., 1870, p. 228.

Three specimens, a male and a female, Cheteriang, Jan. 8 and 10, 1904, and another female, Hainan, Jan. 10, 1903.

These specimens differ very much in color, and also in age. The male is a middle-aged adult, while one of the females is very old, so old that all the sutures of the skull are completely obliterated and the teeth worn down to the roots. The male is dark grayish brown, with the usual head pattern of white spots; the stripe on the crown is continued posteriorly with only slight interruption to the shoulders; the ventral surface is of the usual strong buffy white; the hairs of the flanks and limbs are rather prominently tipped with whitish, resulting in a decided grayish effect; the tail is quite clear white for rather more than the apical half, and the hairs of the basal portion have long whitish tips.

Of the other two specimens, both females, one is like the male in coloration, but with less white on the tail; the other, although shown by the skull to be very old, is much darker brown above, with much shorter, inconspicuous light tips to the hairs on the flanks and limbs, and the tail is brown almost to the tip, with the ends of the hairs lighter, chiefly on the terminal pencil. The ventral surface and the underfur on the limbs are deep rusty ochraceous. The furred portion of the nose, almost as far back as the eyes, is gray instead of dark brown, and the white crown spot and shoulder spot are greatly reduced in size. Mr. Swinhoe's single specimen (*l. c.*) was, according to his description, about intermediate in coloration between the two phases above described, except that it lacked the white spot between the eyes. It is thus evident that there is a considerable range of apparently purely individual variation in color in even Hainan specimens.

24. **Ursus** sp.

Ursus tibetanus SWINHOE, P. Z. S., 1870, p. 230.

Mr. Swinhoe says he was shown "a large black shaggy skin" of a bear said to have been taken in Hainan, which he judged to be *U. tibetanus* "rather than of *Ursus malayanus* Horsf."

25. **Crocidura (Pachyura) murina** *Auct.*

Sorex myosurus SWINHOE, P. Z. S., 1870, p. 231.
Sorex murinus SWINHOE, P. Z. S., 1870, p. 620 (the reference to Hainan).

One specimen, adult male, Manrin, June 11, 1903.

The proper name of the Oriental shrew commonly known as "*Sorex murinus* Linn." or "*Crocidura murina*," I have not the means at present to determine. Linnæus's *Sorex murinus* (Syst. Nat., ed. XII, 1766, p. 74) is indeterminable from the brief diagnosis beyond the point that it was some kind of a shrew, with "Habitat in Java." As this island is now known to be the home of a considerable number of species of *Crocidura*, Linnæus's diagnosis is wholly indeterminate. It therefore remains for some one to establish the correct name of the so-called *C.* "*murina*" of southern Asia, and to determine its geographical races, its alleged range extending from Arabia to Japan.

Swinhoe (*l. c.*) says: "The Muskrat was common in the houses in the capital city, and I was often disturbed in my room at night by its clinking note." He does not mention having taken or examined specimens.

26. **Tupaia modesta** sp. nov.

Type, No. 26654, ♂ ad., Lei-Mui-Mon, Hainan, Jan. 5, 1903.

Above olivaceous gray, a little darker along the middle of the back than on the flanks and limbs, and with a very slight rufescent tinge on the rump and; thighs; no trace of dorsal or shoulder stripes; fur soft, mixed with stiffer, longer black-tipped hairs; basal half of fur slaty, the apical half ringed with yellowish olive and black; ventral surface yellowish gray, brighter on the breast, forenecks throat, median line, and anal region; on the foreneck the color deepens to yellowish buff; tail above like the back, below with the central line of short hair, buffy gray, the longer hairs, which are quite coarse and 22–24 mm. long, ringed alternately twice with pale yellowish gray and black, the outer bands much broader than the inner, the tips of the hairs yellowish; the tail pattern below is thus a broad central band of yellowish gray, with, on each side, a narrow band of black, then a broader one of pale grayish buff, and another still broader of black, with a buffy outer fringe; feet dull yellowish-gray brown; ears dull dark brown, thinly haired.

Measurements (type, from skin).—Total length, 328; head and body, 178; tail vertebræ, 150; tail to end of hairs, 177; hind foot, 43 (with claws 47) mm.

The skull agrees in size and general form with the *T. ferruginea* group. None of the series of seven skulls is perfect enough to furnish a complete series of measurements, the occipital region in all being defective. Total length (type), 50; palatal length, 26.5; palatilar length, 24; zygomatic breadth, 26; least interorbital breadth, 24.5; width of braincase, 19; maxillary toothrow, 18; diastema, 6; mandibular toothrow, 6; mandible, front border of symphysis to condyle, 34 mm.

Seven specimens, collected as follows: Lei-Mui-Mon, in the mountains of central Hainan, 5 specimens, Jan. 5–11, 1903; Utoshi, 1 specimen, March 20, 1903; Hoi-how, on the northern coast of Hainan, 1 specimen, Jan. 4, 1903.

This series, with one exception, is exceedingly uniform in coloration; one or two show a little more of a rufescent tinge on the lower back than do the others. The Hoi-how specimen, however, differs from all the others in having the throat tawney ochraceous. It is the youngest of the series, although practically full-grown, and this bright color may be a feature of immaturity, or it may indicate a more richly colored coast form.

The genus *Tupaia* appears not to have before been reported from Hainan. Its Hainan representative does not appear to be closely related to any of the previously described forms, it differing very markedly in coloration from any of the species of the mainland, and is still less closely allied to any of the numerous insular forms.

27. **Nyctinomus plicatus** *Buch.-Ham.*

Five specimens, all adult males, Rintoi, July 1, 1904. Very uniform in coloration. Forearm, 50–51 mm.

28. **Rhinolophus hainanus** sp. nov.

Type, No. 26748, ♀ ad., Pouten, Hainan, July 2, 1904.

Ears large, broad, rather abruptly pointed, the outer margin slightly emarginate below the tip; antitragus large, separated from the outer border of the ear by a deep hollow; noseleaf rather small, pointed; sella nearly quadrate, about twice as high as broad, the basal anterior extension forming an oval cup as in *R. mitratus* (as described and figured by Dobson, Mon. As. Chirop, p. 42, fig. *a*); lower lip with three deep grooves. Above the general effect is dark russet brown (in type), varying in different specimens to plain dark brown without rufous tinge; in detail, in the russet phase the basal three-fourths of the pelage is suffused with fulvous or golden, lightening basally; in the darker phases the basal rufous suffusion is more or less obsolete, quite disappearing in the darkest specimens, but is generally pale yellowish gray. Ventral surface similar to the dorsal but much paler. Ears and membranes dark brown. Tail much shorter an the tarsus, the extreme tip slightly projecting beyond the membrane.

Length of head and body (type), in dry skins, about 55; tail, 16; ear from crown, 18, width, 15; forearm, 50; 3d metacarpal, 35; 5th metacarpal, 37; 4th intermediate between them; tibia, 22.3; wing membrane terminates 3 mm. above the tarsal joint.

Skull, total length, 22; zygomatic breadth, 10.5; mastoid breadth, 10; width of nasal protuberance, 5.5; length of palatal bridge, 4; upper toothrow, 9; lower toothrow, 9.5; length of mandible, 15.5 mm. Skull broad; nasal protuberance broad but low; p^2 in the toothrow, very distinct; p^3 external, p^2 and p^4 in contact.

It is seemingly rash to attempt to add another species to the list of one hundred or more species and subspecies recently listed under the genus *Rhinolophus*,[1] but in the present case there seems to be no alternative; the species of the adjoining mainland, including the Malay Peninsula, and also from elsewhere, which approach it at all nearly in size are excluded by structural characters of the noseleaf or skull and dentition. It seems to agree best with *R. mitratus*, as described and figured by Dobson, in the character of the ears and nasal appendages; but this species is much larger, having a forearm of 57 mm., whereas the average of 27 specimens of *R. hainanus* is 50 mm., the extremes 49 and 51 mm.

Based on 27 skins, 20 males and 7 females, collected at Pouten, July 2 and 3, 1904. As noted above, there is a considerable range of color variation, dependent upon the amount of rufous suffusion of the pelage, particularly of the basal portion, in general effect the color of the upper parts ranging from russet brown, with the basal portion of the pelage pale golden, to plain dark brown, with the basal portion of the pelage grayish with faint yellowish tinge.

29. **Hipposideros poutensis** sp. nov.

Type, No. 26698, ♂ ad., Pouten, Hainan, July 2, 1904.

Adult.—Ears large, nearly as broad as high, thick and leathery, with 7 or 8 transverse ribs, the lower ones longest and heaviest; inner border nearly straight, becoming convex near the tip, which is short and rather obtuse; outer border slightly hollowed below the tip; upper transverse portion of the noseleaf narrow, slightly convex, the free portion about 8 mm. transversely and 2.5 mm. high, or about as wide (transverse measurement) as the horseshoe, the anterior face with three vertical ridges, most distinct basally; horseshoe with a slight notch on its free border, and with three small leaflets on either side; no frontal sac behind the noseleaf, or at least none distinguishable in even softened skins; wings from the distal fifth of the tibia; tail very pointed, most of the last vertebra exserted; thumb short, with the nail about 7 mm.; feet short, about 9 mm. without the claws.

Color above (type), at the surface russet brown, basal two-thirds of the fur pale buffy gray; below similar but much paler, the hairs slightly gray-tipped; ears brown, membranes blackish brown.

Measurements.—Type (from softened, well-filled skin), head and body, 62; tail, 28; forearm, 60; thumb, 7; 3d metacarpal, 43; 4th, 43; 5th, 41; 3d finger

---

[1] *Cf.* Andersen, Ann. and Mag. Nat. Hist. (7), XVI, Dec., 1905, pp. 648, 652.

(with metacarpal), 82; 4th finger, 65; 5th, 65; tibia, 23; calcaneum, 10; foot 9 mm. The forearm averages 60.6 in a series of 27 adult specimens, ranging from 58 to 63, with 6 at 60, 15 above 60, and 6 below 60.

Skull (of type), greatest length, 24; zygomatic breadth, 13; width at nasal protuberance, 8; mastoid breadth, 11; width at outer base of canines, 6.5; upper lateral toothrow (including canine), 9; length of lower jaw, 16.

Young.—Ears smaller, thinner, less prominently ribbed; nasal appendages as in the adult but less developed. Color above seal brown to slaty brown, without or with very slight reddish brown suffusion, the basal portion of the fur whitish gray in the darker specimens, faintly buffy gray in the seal brown specimens; below dark grayish brown to dull drab, the hairs slightly light-tipped.

Size smaller, forearm averaging 58.3, ranging from 57 to 60 mm., as against 60.6 (58–63) in the adults. Greatest length of skull 21 or more, or 2 to 3 mm. less than in adults.

Represented by 50 specimens, of which 27 were collected at Pouten and 23 at Porten, July 2 to 4, 1904. It singularly happens that all the Pouten specimens, except one, are adults and all the Porten specimens, except one, are immature.

The variation in color in the adults is considerable, ranging from golden russet to seal brown above, and correspondingly below. The young specimens vary from blackish to seal brown. Quite a number have the hairs obscurely tipped with gray, above as well as below.

This species is doubtless closely related to *Hipposideros leptophyllus* (Dobson), from the Khasia Hills, eastern Bengal, but differs from it in being considerably smaller, and in many details of structure, as in the smaller ears, relatively much shorter tail, broader transverse portion of the noseleaf, etc. It also seems quite near *H. larvatus* (Horsfield), as described by Dobson, also from the Khasia Hills, and thence southward through Burma and Siam to "Java."

30. **Hipposideros fulvus** *Gray.*

Thirteen specimens, collected as follows: Rintoi, 6 specimens (4 males, 1 female, 1 without indication of sex), July 1; Rinsui, 7 specimens (4 males, 3 females), July 1. All are adult except two immature examples from Rinsui.

The Rintoi specimens are all in the bright fulvous pelage, the basal portion varying, however, in different specimens from pale yellowish white to bright golden, and the surface tint from bright yellowish russet to dark brown. The Rinsui specimens are all in the mouse brown pelage, with the basal two-thirds of the pelage nearly white, except one which matches the darkest of the Rintoi series. Forearm, Rintoi series, 39 (38.5–40); Rinsui series (the adults), 38.5 (38–39).

The Rintoi series represents Gray's *H. fulvus;* the Rinsui series his *H. murinus.* The species is evidently dichromatic.

31. **Miniopterus schreibersi** (*Natterer*).

Three specimens, all females, Rinsui, July 2.

Forearm, respectively, 50, 49, 48.5 mm. Color above dark reddish brown, below paler.

32. **Miniopterus pusillus** *Dobson.*

Thirteen specimens, 9 males, 4 females, all adult, of which 3 are from Rintoi and 10 from Rinsui, all collected July 2.

Similar in color and structurally to Hainan Island specimens of *M. schreibersi,* but much smaller. Forearm (13 specimens), 40.6, ranging from 40–41.5 mm.

33. **Scotophilus kuhlii insularis** subsp. nov.

Type, No. 26786, ♂ ad., Rintoi, Hainan, July 1, 1904.

Similar to *S. kuhlii* but much larger; forearm 66 as against 60.5 mm. in *S. kuhlii.* In three adults the forearm measures respectively, 1 ♂, 67, 2 ♀'s, 64 and 67; an immature ♂ (phalangeal epiphyses still free), 63.

Color above uniform olive brown; below pale brownish buff, darker on the sides. Ears, skull, and dentition as in *S. kuhlii.*

The skulls of all the specimens are imperfect, lacking the occipital portion. The available measurements of the type skull are as follows: Greatest orbital breadth, 10.2; least postorbital breadth, 6; breadth at outside base of canines 8.7; length of upper toothrow excluding incisor, 8.6; length of lower jaw, 18; height at coronoid, 7.7; length of lower lateral toothrow, 10 mm.

Based on 4 specimens, two males and two females; the two males were taken at Rintoi and the two females at Rinsui, all on July 1, 1904 The four specimens form a very uniform series as regards coloration, both above and below. According to Bonhote (P. Z. S., 1900, p. 192), the average length of the forearm in "*S. kuhlii* is 60.5 mm., showing a variation from 58–63." The maximum thus barely equals an immature specimen of the present series in which the epiphyses of the phalanges are still free, while two of the adults have a forearm of 67 mm. Dobson gives the length of the forearm in *S. heathii* as 2.45 in. (=62.23 mm.); according to Blyth, the forearm in his *Nycticejus luteus* is still less—60.2 mm.

34. **Scotophilus castaneus consobrinus** subsp. nov.

Type, No. 26788, ♀ ad., Rintoi, Hainan, July 1, 1904.

A 'little brother' of the *S. kuhlii* group, distinguished mainly by small size; Above (adult, type) yellowish brown; beneath similar but much paler. structure of the ear as in *S. kuhlii,* even to the presence of the obliquely transverse rib across the front base of the tragus.

Forearm (in type) 50, averaging 51 in 9 adults, and ranging from 50–52 (only 2 above 51), as against 66 (64–67) in *kuhlii insularis*. Skull (type), total length, 18.5; greatest orbital breadth, 7, as against 10.2 in *kuhlii insularis;* least postorbital breadth, 5; breadth at outside base of canines, 6.2; upper lateral toothrow (excluding incisor), 6.3; length of lower jaw, 9; length of lower lateral toothrow, 7 mm.

Young darker, more olive brown and less yellow; also smaller, with the forearm ranging from 46–48, with one at 50 mm. Transverse ridge on front base of tragus wanting, as it is also in immature specimens of the *kuhlii* group.

Represented by 17 specimens, of which 9 are adult and 8 are immature; 13 were collected at Rintoi, July 1, and 4 at Rinsui, July 2. The adults range in coloration of the upper parts from cinnamon brown to dark wood brown, according to the amount of yellowish suffusion; underparts yellowish buff, varying in different specimens from buff to ochraceous buff. The young of the year (smaller and with free epiphyses) darker, mostly with a decided olivaceous shade above and a brownish tinge below. Most of the young specimens are scarcely distinguishable in color of upper parts from the adults of *S. kuhlii insularis*, but the adults are much more yellowish.

There are only two species of Asiatic *Scotophili* with which the present species needs comparison,—*S. wroughtoni* Thomas, from Surat, British India, and *S. castaneus* Horsfield, the three species having practically the same measurements (average length of forearm in all, 50–51 mm.). For *S. wroughtoni* the length of the forearm is given as 50 mm.; Bonhote (P. Z. S., 1900, p. 192), for *S. castaneus*, says "the average length of the forearm of the 5 specimens in the [British] Museum is 50.7 mm., the lengths ranging from 49–52"; in 9 adults of *S. consobrinus* the forearm averages 51, ranging from 50–52. Bonhote (*l. c.*) says the color of *S. castaneus* "is of a uniform chestnut all over, showing no tendency to become lighter below"; while Thomas says *S. wroughtoni* is "uniform brownish from above without any tinge of yellowish; the hairs white at their bases and gradually darkening to the brownish tips; . . . undersurface very pale fawn, almost white." In neither does the coloration agree with that of *S. consobrinus*, none of the 17 specimens of which approach chestnut, either above or below; in several there is a decided suffusion of yellow, especially on the under surface, which is decidedly lighter than the upper surface; the basal portion of the fur is not white, being on the upper surface only a little lighter than the tips, with rather more difference on the ventral surface between the apical and proximal portions. It seems probable that *consobrinus* is more closely allied to *castaneus* than to any other described form, of which it is doubtless the Hainan insular form.

35. **Murinus cyclotis** *Dobson.*

One specimen, adult female, Youboi, June 21, 1904. Forearm, 33.

This specimen agrees satisfactorily in nearly all particulars with Dobson's description and figures of *M. cyclotis*, from Darjiling, in the Himalaya. The fur, however, is not very distinctly bicolor, the bright rufous extending nearly the whole length of the hair on the dorsal surface, only the extreme base showing a darker, brownish shade; below a lighter, more yellowish brown to the base of the fur. The present specimen (dry skin) has a smaller ear (14 as against 15.3 mm.) and a shorter tragus (7.5 as against 9), a longer thumb (metacarp. 5 instead of 2.5; ph. 7 without claw, 8.5 with claw, instead of 5), and apparently a longer tibia (17 as against 15.2). As some of these discrepancies may be more apparent than real, due to the measurements being taken in the one case from an alcoholic specimen, and in the other from a skin, it seems best provisionally to refer the present specimen to *cyclotis;* there is a close agreement in dentition, size, color, the hairiness of the interfemoral membrane and feet, etc., notwithstanding the great geographical separation of the two localities, Hainan and the Himalaya. A single specimen ("♀ imm."), however, has been recorded by Dobson from Ceylon.

36. **Pipistrellus portensis** sp. nov.

Type, No. 26797, ad. ♂, Porten, Hainan, July 4, 1904.

Similar in the form of the ear and the structure of the incisors and premolars to *P. tenuis* Temminck, from "Sumatra, Java, and Borneo," as described by Dobson (Cat. Chirop., 1878, 226), but much larger.

Color above (adult, type) dark reddish brown, the short, fine fur colored uniformly to the base; underparts rather lighter and duller; membranes black; ears small, obtusely pointed, the outer margin nearly straight; tragus rather narrow, of nearly even width almost to the obtusely rounded summit, with a small lobule at the outer base; tail pointed, the greater part of the last vertebra exserted; wings from the ankles; well-developed post-calcareal lobules.

Head and body (from a well-made skin, the type), 42; tail, 27; forearm, 32; ear, 9; tragus, 4; tibia, 12; foot, 7. Forearm, 12 specimens, 32 (31–33). Greatest length of skull, 12, to tip of incisors, 13; greatest width of braincase, 6.8; length of lower jaw, 9 mm.

The species is dimorphic, having a dark reddish brown phase and a nearly black phase; rather more than one-half of the adults and about one-third of the immature specimens are in the brown phase, the remainder in the dark phase, varying from deep black to brownish black.

Represented by 28 specimens, of which 11 are adult and 17 more or less immature. The series of immature specimens, in which the phalangeal epiphyses are still free, have the same length of forearm as the adults—32 (31–33, with one very young one at 29) mm. The specimens were collected as follows: Porten, 21 specimens, July 4; Rinsui, 5 specimens, July 2; Rintoi, 1 specimen, July 2; Manrun, 1 specimen, June 20.

P. portensis is nearest *P. tenuis*, and is therefore quite different from *P. ridleyi* Thomas, from Selangore, Malay Peninsula, which, according to the description, is much smaller (forearm 28 instead of 32 mm.), and has quite different ears and dentition. In the latter respects, *P. portensis* closely resembles *P. tenuis*, from which it differs in larger size (forearm 32 instead of 26.7 mm.) and in smaller ears, and doubtless in other respects. It differs from *P. abramus*, as described by Dobson, in smaller size, darker color, and in having the inner upper incisor shorter instead of longer than the inner cusp of the outer incisor.

37. **Myotis davidii** (*Peters*).

One specimen, Rintoi, July 2.

This specimen agrees very closely with the description by Peters and Dobson of *M. davidii* (type locality, Pekin, China), differing in being larger (forearm 34 instead of 31.5 mm.), and in the color of the upperparts, which are nearly black frosted with whitish tips, instead of fur "dark with light brown tips." It agrees with *M. davidii* in having the wing membranes from the feet and a long calcaneum, in the size and shape of the ears, and in the small size and internal position of the second premolar in both jaws. It is quite probable that comparison of suitable material from the type locality and from Hainan would show that the Hainan form is entitled to separation.

38. **Myotis abramus** (*Temm.*).

Vesperugo abramus Swinhoe, P. Z. S., 1870, p. 227.

Swinhoe says: "I only procured one small Bat at Hainan—the species which roosted under the eaves of the house in the city wherein I was quartered. Dr. Peters, of Berlin, has kindly determined the species. It is a common House-bat in Nagasaki, Japan."

On this basis *Myotis abramus* is here included.

39. **Macacus rhesus** (*Audebert*).

Macacus erythræus Swinhoe, P. Z. S., 1870, pp. 226, 615.

One specimen, skin and skull, adult male, Heuron, Hainan, May 10, 1904.

Swinhoe found them very common about the jungles of Nychow, southern Hainan.

40. **Semnopithecus nemæus** (*Linn.*).

Semnopithecus nemæus MEYER, P. Z. S., 1892, 665 (in litt.).

Dr. Meyer (*l. c.*) has reported the receipt at the Dresden Museum of a specimen of this species from the island of Hainan. He says: "Not being aware that *Semnopithecus nemæus* has been recorded from the island of Hainan, but only from Cochin China, I beg to state that the Dresden Museum has recently received a male specimen of this monkey together with other objects from there."

This is the only evidence I have for the inclusion of this species in the present list.

41. **Hylobates hainanus** *Thomas*.

"*Great Black Ape*, DU HALDE, Description de la Chine, 1735, 230."

Hylobates pileatus SWINHOE, P. Z. S., 1870, 224 (not of Gray).

Hylobates hainanus THOMAS, Ann. and Mag. Nat. Hist. (6), IX, Feb., 1892, 146; POCOCK, P. Z. S., 1905, Vol. II, pt. 1, pp. 169–180, pl. v.

Du Halde (*l. c.*) reported, in 1735, the existence of a great black ape in Hainan, but referred to it as rare, and gave of it little additional information. Swinhoe, in 1870, referred to Du Halde's account, and confirmed the occurrence of such an animal in the island, but was unable to secure specimens, and was unable even to see a living example, although the species was well known to the natives and was sometimes kept by them in confinement.

In 1892, Thomas described a gibbon from Hainan, presumed to be the species doubtfully referred by Swinhoe to *Hylobates pileatus* Gray, the description being based on a specimen presented to the British Museum by Mr. W. T. Lay, "to whom it was brought alive from the island, and in whose care it lived for about four years in China." The animal is described as wholly jet black, and while resembling *Hylobates hoolock*, differs from it, and from all other known species, "by the entire absence of the white superciliary streak."

Pocock, in 1905 (*l. c.*), published some interesting observations on a female specimen then living in the Gardens of the London Zoölogical Society, procured in the island of Hainan, on July 11, 1897.

BIBLIOGRAPHY.

1892. MEYER, A. B. [*Semnopithecus nemæus* from the Island of Hainan.] *Proc. Zoöl. Soc. London*, 1892, p. 665.

Records, in a letter to the Secretary of the Zoölogical Society, a specimen of *Semnopithecus* received at the Dresden Museum from

Hainan, which he was unable to distinguish from "the description and figures of the continental animal, *S. nemœus.*"

1905. Pocock, R. I. Observations upon a female Hainan Gibbon (*Hylobates hainanus*), now living in the Society's Gardens: *Proc. Zoöl. Soc. London,* 1905, Vol. II, pt. 1, Oct., 1905, pp. 169–180. pl. v.

Observations on age at maturity, menstruation, determination of sex, change of color, description of the nomenclature, species, etc.

1869. Swinhoe, Robert. On the Cervine Animals of the Island of Hainan (China). *Proc. Zoöl. Soc. London,* 1869, pp. 652–660.

Three species: *Cervulus vaginalis*, *Panolia eldi*, and another closely allied to *Cervus aristotelis*. There are remarks on other unidentified species, not seen by the author.

1870. Swinhoe, Robert. On the Mammals of Hainan. *Proc. Zoöl. Soc. London,* 1870, pp. 224–239, pl. xviii.

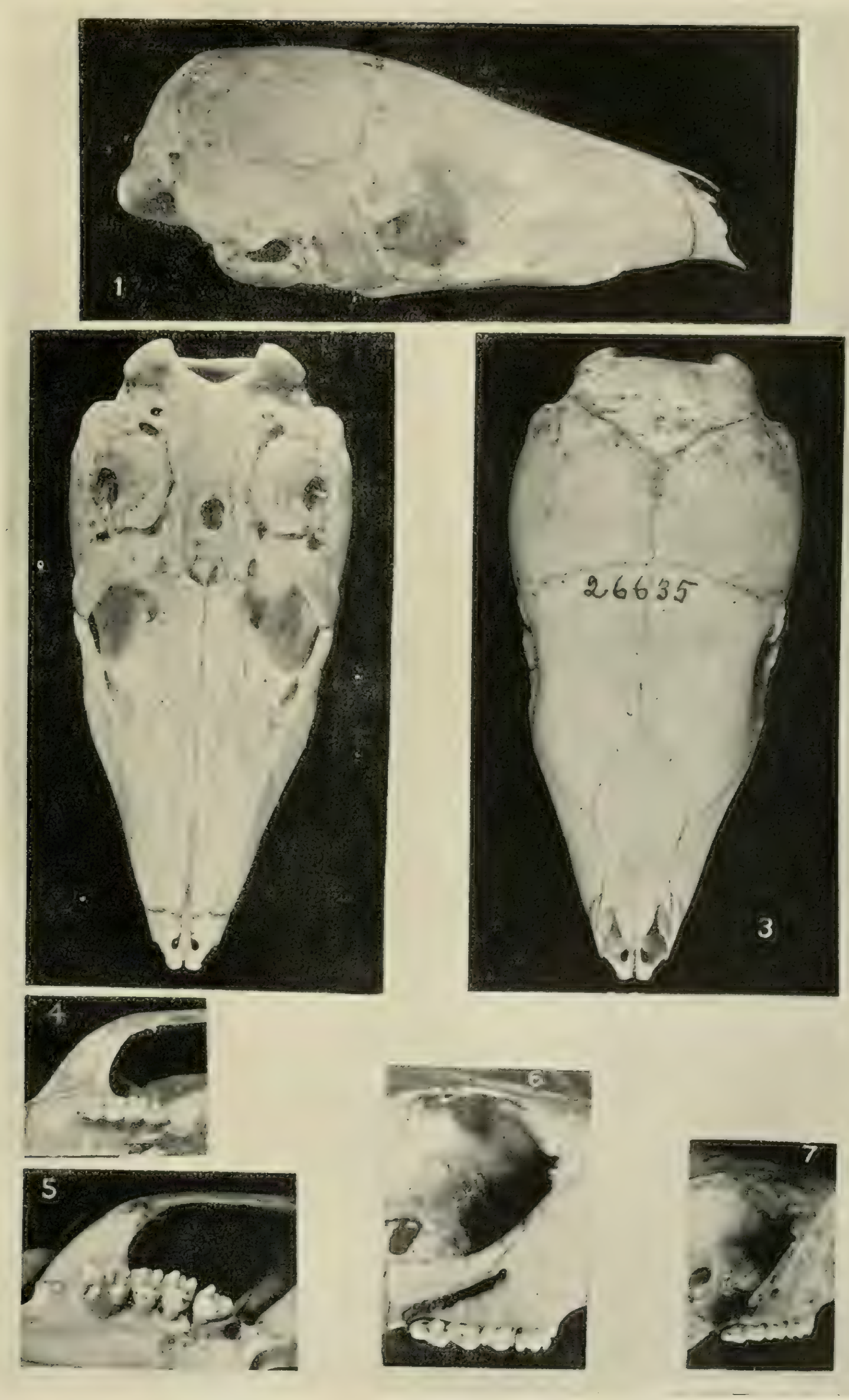
An annotated list of 21 species, "actually seen or procured in whole or in part" by the author, with notes on others, domestic and wild, taken from the 'Hainan Gazetteer.' *Lepus hainanus*, sp. nov.

1892. Thomas, Oldfield. Note on the Gibbon of the Island of Hainan (*Hylobates hainanus*, sp. n.). *Ann. and Mag. Nat. Hist.* (6), IX. Feb., 1892, pp. 145, 146.

ADDENDUM.

Since the foregoing was put into page form I have received, through the kindness of Professor William Morton Wheeler of this Museum, a letter from Mr. Alan Owston of Yokohama, from whom the collection was purchased, enclosing a sketch-map of the island of Hainan on which are indicated the localities at which the collection was made, with other important information. I find that, as I had suspected (see *antea*, p. 465), **Porten** and **Pouten** are different names for the same locality; the same is also true of **Rinsui** and **Rintoi**, of **Liudon** and **Riudon,** and of **Manrin** and **Manrun,** these alternative names being transliterated from different Chinese dialects.

The principal localities are situated as follows: **Cheteriang** is in the mountains near the southern border of the island; **Porten** is near Cheteriang, but a little to the southward and at a lower elevation; **Rinsui** (or Lingsui) is on the southeast coast, a few miles inland; **Manrin** is also on the southeast coast, to the northeast of Rinsui; **Youboi** is near the coast, between Rinsui and Manrin; **Mount Wuchi** (or Uteriang) is in the south-central part of the island; **Lei-Mui-Mon** is in the mountains a little north of the center of the island; **Liudon** (or Riudon) is in the lower country northeast of Lei-Mui-Mon; **Utoshi** (or Wutoshi) and **Taipin** (or Taipinshi) are between and to the southward of Lei-Mui-Mon and Liudon; **Hoi-how** is on the northern coast, to the eastward of the middle of the island.



Figs. 1-3, *Manis pusilla*, sp. nov. $\frac{1}{1}$ Figs. 4 and 5, *Sciurus vulgaris* L. $\frac{2}{1}$ Figs. 6 and 7, *Tamiops macclellandi hainanus*, gen. et subsp. nov. $\frac{2}{1}$

56.57,93(118.78 8)

Article XXIX. — FOSSIL PARASITIC AND PHYTOPHAGOUS HYMENOPTERA FROM FLORISSANT, COLORADO.

By CHARLES T. BRUES.

Several months ago I received through the kindness of Professor T. D. A. Cockerell and Professor Wm. M. Wheeler, a collection of fossil Hymenoptera from the famous tertiary lake basin at Florissant, Colorado. With the exception of a single Oryssid, only parasitic forms were included in the sending, and these constitute the basis of the present paper.

All represent species not hitherto described, but this is not surprising as the Florissant fauna belonging to these groups has never been exploited, except for a series of seven species described by Scudder in his Tertiary Insects.[1]

The present collection contains about 25 specimens, and only one, or possibly two species are represented by more than a single example. Nine species are well enough preserved to be placed generically, and only one is not assignable to any described genus.

From such a fragmentary series it is impossible to draw any general conclusions regarding the relation of the fossil parasitic fauna of Florissant to the present-day Hymenoptera of the same region, but the similarity among the few species I have seen is quite close, and will warrant the assumption that the general character is likewise similar. This agrees with the conclusion reached by Cockerell[2] from a study of the bee fauna, rather than with the opinion of Scudder that the insects of Florissant show decidedly southern affinities. Many of the genera of parasitic Hymenoptera are very widely distributed, however, and too much weight must not be placed on the slender evidence which the present collection affords.

In the following account generic names have in some cases been applied of necessity *sensu lato* as the finer discriminations applicable to recent species are usually impossible in studying fossils.

The entire collection, including the types, is in the American Museum of Natural History.

ORYSSIDÆ.

Lithoryssus gen. nov.

Small species resembling *Oryssus* in general habitus, but with the ovipositor

---

[1] Report U. S. Geological and Geographical Survey of the Territories, Vol. XIII (1890).

[2] Fossil Hymenoptera from Florissant, Colorado. Bull. Mus. Comp. Zoöl. Harvard Coll., Vol. L, No 2 (1906).

projecting beyond the tip of the abdomen for a distance nearly equal to the length of the abdomen. Wings with only one closed submarginal cell, a second closed one perhaps very faintly indicated by a tranvserse vein. The humeral area apparently undivided. Antennæ 8- or 9-jointed, the flagellar joints equal in length or nearly so, except the first. Abdomen wider than the thorax, consisting of seven nearly equal segments. Type *L. parvus* sp. nov.

The specimen upon which this genus is founded cannot be placed in any recent genus and I have been compelled to define a new one for its reception. It would seem to fall into the subfamily Oryssinæ as defined by Konow [1] where it comes nearest to *Oryssus*, from which it differs as pointed out above.

Lithoryssus parvus sp. nov.

Female. Length 3.5 mm. Black, the abdomen brownish or rufous. Wings with a brownish tinge. Antennæ 8- or 9-jointed, more probably 9, the apical five or six joints nearly equal in length, each about two and one-half times as long as wide, the first (?) flagellar joint longer and narrowed basally. Wings with the costal and subcostal veins thickened, not united at the root of the wing; submedian cell much longer than the median. First submarginal cell a little more than two times as long as high, narrowed at the tip; second submarginal open, receiving the recurrent nervure one-fourth of the way from the first transverse cubitus to wing tip. Second transverse cubitus perhaps feebly indicated, but not distinct.

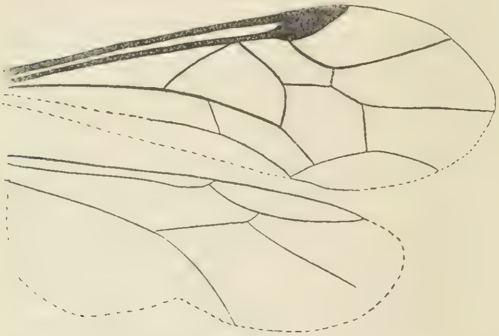


Fig. 1. *Lithoryssus parvus* sp. nov. Wings. Dotted lines are restored.

Described from one specimen seen in dorsal aspect, collected in a bank facing north, three-quarters of a mile southwest by west of Florissant, Colorado.

ICHNEUMONIDÆ

SUBFAMILY CRYPTINÆ.

Mesostenus modestus sp. nov.

Length 5.5 mm. This is a rather poorly preserved specimen, but is I think surely a member of the tribe Mesostenini on account of the wing venation and the characteristic tubercle at the lateral metathoracic angle. This latter is shown very distinctly; it is rather pyramidal and projects somewhat laterally. The anterior wing is well preserved. Stigma about one-third as wide as long and almost one-half as wide as the marginal cell. Basal nervure slightly curved, the median and submedian cells of equal length. Subdiscoidal nervure of anterior wing broken just below the middle. Areolet triangular in position, but open behind; the second recurrent nervure curving toward the base of the wing, above received by the cubitus as far beyond the transverse cubitus as the length of the transverse cubitus, or a little further. Third discoidal cell apparently open at the extreme tip. The tips of the antennæ are broken off, but the first few flagellar joints are about two or two and one-half times as long as wide. The abdomen is about as long as the head and thorax together, the ovipositor stout, apex missing.

---

[1] Term. Füz., Vol. 20, p. 602 (1897), and Gen. Insectorum, Fasc. 28, p. 9 (1905).

One specimen from the north end of Fossil Stump Hill, Florissant, Colorado.

Although not especially well-preserved, I think this belongs undoubtedly either in the genus *Mesostenus* or one of its near allies. It apparently lacks the bright colors characteristic of many of our recent species of *Mesostenus*, the head and thorax being uniformly black and the abdomen fuscous. The legs are more of a honey-yellow

SUBFAMILY PIMPLINÆ.

Accœnites defunctus sp. nov.

Female. Length 5 mm. Antennæ with about 22 joints, slender, involute, reaching about to the tip of the abdominal petiole. Mesonotum with parapsidal furrows, or at least the middle lobe is raised anteriorly above the humeri. Metanotum with a transverse carina, and rather distinctly areolated, sharply declivous behind. Pleuræ with the vertical sutures crenulated. Abdomen strongly enlarged toward the tip, the ventral valve prominent, extending considerably beyond the tip of the abdomen. First abdominal segment long, equalling the second to fifth together, straight, gradually enlarged toward the tip. Second to sixth segments nearly equal, the third to fifth much thicker dorsoventrally, being two and one-half times as high as long; sixth rounded above at the tip. Ovipositor apparently about half the length of the abdomen although it is too faintly preserved to be made out distinctly and may possibly be much longer. Wings with the recurrent nervure received beyond the first transverse cubitus, the areolet absent. Submedian cell barely longer than the median. The wing of the type specimen is broken basally, so that the shape of the first basal cell shown in the drawing is distorted.

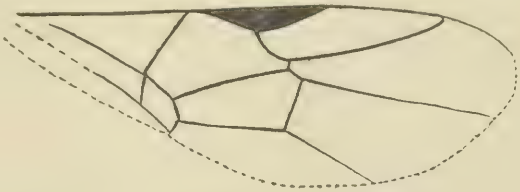


Fig. 2. *Accœnites defunctus* sp. nov. Fore wing. Dotted lines are restored.

Described from one specimen from a bank facing north, three-fourths of a mile southwest by west of Florissant, Colorado.

The species is a typical representative of the tribe Acœnitini as defined by Ashmead[1] but its place in the genus *Acœnites* is less certain the presence of parapsidal furrows being doubtful as the specimen is seen in lateral aspect. However, there seems to be nothing to exclude it and I have placed it here at least provisionally. Although much smaller it resembles our recent native species of the allied genus *Arotes*, from which it differs in neuration.

A fossil species of this genus has already been described as *A. luridus* by Giebel, from the Mayencian of Radoboj in Croatia.

Rhyssa petiolata sp. nov.

Female. Length 7 mm. Ovipositor 9 mm. Body rather roughly sculptured except the four apical abdominal segments. Antennæ long and slender, not well preserved. Mesonotum obliquely striated on each side of the median line. Metathorax areolated. First abdominal segment four times as long as thick, its sides sub-parallel, with a deep groove and carina on each side below, its surface rugulose; second segment about as long as the first, coriaceous; third, fourth, and fifth increasing in size (seen from the lateral aspect), sixth and last small, triangular. Ovipositor issuing apparently at the tip of the fifth (not sixth) ventral segment. Distinctly longer than the body. Hind legs long, their femora rather slender. Wings very poorly preserved, the areolet apparently open.

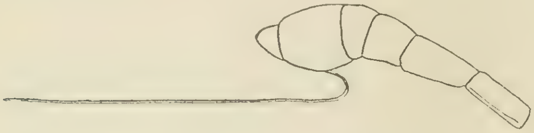


Fig 3. *Rhyssa petiolata* sp. nov. Abdomen and ovipositor

One specimen, lateral aspect, both impressions, from a bank facing north, three-quarters of a mile southwest by west of Florissant, Colorado, collected by Mrs. Wilmatte P. Cockerell.

The habitus of this species is very like that of *Rhyssa*, but the differences in the length of the basal abdominal segments may be of generic importance. Unfortunately the wings are very poorly preserved.

Pimpla appendigera sp. nov.

Female. Length 7 mm. Ovipositor 5.5 mm. Head turned so as to show the dorsal aspect, about three times as wide as thick antero-posteriorly. Antennæ 30- or 31-jointed, the basal flagellar joints about three and one-half times as long as thick, decreasing in length, so that the joints near the middle are two times as long as thick, from thence narrower and a little shorter. All joints, especially the apical ones, are distinctly strigose or finely longitudinally fluted. The antennæ are about three-fourths as long as the body. Mesonotum apparently smooth and without parapsidal furrows. Propleuræ coarsely rugulose, mesopleuræ smooth, finely punctured below. The metathorax appears to be

---

[1] Proc. U. S. National Museum, No. 1206, p. 46 (1900.)

coarsely rugose and its spiracles are round. The legs are shaped as in *Pimpla conquisitor* Say: four posterior femora dark at base and apex and pale medially; their tibiæ pale except at apex; tarsi dark. Abdomen as long as the head and thorax, apparently with a granular sculpture; sessile, the first, second, and third segments subequal in length, the second a trifle longer than the third. The abdomen widens out sickle-shaped toward the apex, but this is probably due to compression of the rock. The ovipositor issues near the middle of the fifth segment, there being six visible segments, the sixth long and probably really composed of more than a single segment. Along the sides of the petiole there is a carina bordering a deep submarginal depression. Wings with the submedian cell a little longer than the median. Discoidal cell with a stump of a vein. Areolet subtriangular, small, subpetiolated.

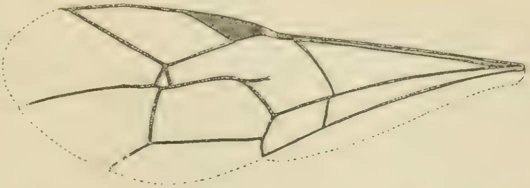


Fig. 4. *Pimpla appendigera* sp. nov. Fore wing. Dotted lines are restored.

One well preserved specimen from the south end of Fossil Stump Hill, collected by Mr. S. A. Rohwer.

SUBFAMILY TRYPHONINÆ.

Orthocentrus primus sp. nov.

Length 4.5 mm. Probably a female. Dark colored, with yellowish wings and brownish yellow tibiæ and tarsi. Antennæ stout, the middle flagellar joints about quadrate, or barely wider than long. Head a little higher than thick, its surface smooth. Thorax twice as long as high, the mesonotum smooth; metathorax areolated, or at least with a distinct transverse carina. Abdomen sessile, clavate, rounded at the tip, one and one-third times as long as the head and thorax together; the first segment a little over twice as long as high at the tip, the second, third, and fourth shorter, subequal. Ovipositor not exserted. Legs and coxæ very stout, the posterior femora fully one-third as thick as long, but this may be due in part to pressure; posterior tibiæ scarcely longer than their femora; their tarsi thickened. Wings with only the basal neuration preserved, the submedian cell a trifle longer than the median, the transverse median nervure strongly oblique. Stigma rather broad, elongate-triangular. Marginal cell pointed at the tip, the radius evenly curved, without sharp angles. Areolet apparently indicated but open behind, the cubito-discoidal nervure but slightly curved.

Described from one impression of a single specimen from a bank facing north, three-quarters of a mile southwest of Florissant, Colorado, collected by Mr. S. A. Rohwer.

The specimen is not especially well preserved, but shows in the full lateral aspect with the characteristic habitus and stout legs of the tribe Orthocentrini. Its place in the genus *Orthocentrus* is less secure.

but the only visible disagreement is in the short flagellar joints which would perhaps indicate it as a species of *Atrometus;* in doubt, I have placed it in the typical genus of the tribe.

BRACONIDÆ.

SUBFAMILY RHOGADINÆ.

Rhogas tertiarius sp. nov.

Female. Length 4.5 mm. Head, thorax, and first abdominal segment black, remainder of the abdomen rufous or ferruginous. Antennæ and legs not preserved. Head almost as wide as the thorax, the sides of the face, clypeus, and mandibles apparently ferruginous, the tips of the latter and the palpi black. Mesothorax showing the parapsidal furrows posteriorly although they are not preserved in front. First abdominal segment showing the median carina quite distinctly and some longitudinal striate sculpture. First segment about quadrate, the second and third subequal, the third a little the longer, together three times as long as the first; fourth narrower, less than one-half as long as the third, rounded at tip. The ovipositor can be seen marked upon the third and fourth segments, due no doubt to pressure; it is not visibly exserted. Wings hyaline, the venation much as in *Rhogas terminalis* Cress. Marginal cell pointed at the tip, the second abscissa of the radius twice as long as the first and three-fourths the length of the third. First abscissa of the cubitus slightly longer than the second, which is about twice the length of the second transverse cubitus. Submedian cell of anterior wing longer than the median by the length of the second abscissa of the radius.

Described from a single specimen from Florissant, Colorado.

SUBFAMILY MICROGASTERINÆ.

Microgaster primordialis sp. nov.

Female. Length 3 mm. Black, the abdomen ferruginous, darker at the tip. Wings tinged with brown, the stigma brown. Antennæ fuscous, rather stout, the flagellar joints not over twice as long as thick. Ovipositor slightly projecting. Front wing preserved only in part; stigma subtriangular, the parastigma distinct. First discoidal cell with a short petiole above where it connects with the parastigma; areolet present, fully closed.

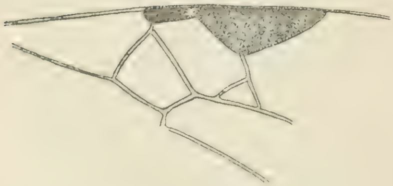


Fig. 5, *Microgaster primordialis* sp. nov. Part of fore wing.

Described from one specimen from a bank facing north, three-quarters of a mile southwest by west of Florissant, Colorado.

Although the specimen is only in part preserved, its systematic position is unmistakable, and the bicolored body will make it readily recognizable.

BELYTIDÆ.

Pantoclis deperdita sp. nov.

Female. Length 5 mm. Body shining black, the antennæ probably brown. The antennæ are not well enough preserved to count the basal joints accurately but are probably 15-jointed, the apical five joints forming a loose submoniliform club; the first two joints of the club are moniliform, while the last two are wider; the joints toward the middle of the flagellum about one and one-half times or twice as long as thick. Prothorax visible from above although short. Mesonotum almost as long as the scutellum and metathorax together, with deep and complete parapsidal furrows. Scutellum with a deep transverse furrow at the base which is fluted longitudinally on the bottom; posterior margin of scutellum crenately punctured, the postscutellum apparently somewhat tuberculate. Metanotum with three parallet longitudinal carinæ dividing it into four equally wide areas; the posterior angles acute. Abdomen as long as the head and thorax, the petiole as long as the 'metathorax and scutellum together; second segment almost covering the rest of the abdomen, longitudinally striate on its basal fifth; following segments together one sixth as long as the second, but their boundaries are not visible in the specimen. The legs are not preserved. Front wings with a small basal cell distinct, and a small closed marginal cell which is scarcely longer than the stigma-like marginal vein.

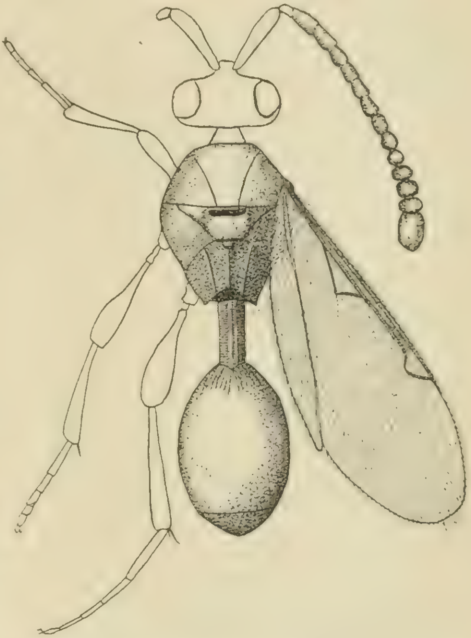


Fig. 6. *Pantoclis deperdita* sp. nov. Restored parts are unshaded.

Described from one specimen in a beautiful state of preservation, found in a bank facing north, three-quarters of a mile southwest by west of Florissant, Colorado.

This species agrees in all visible features with the species of this widely distributed recent genus and undoubtedly belongs here, being closely related to several present day forms from our region.

BETHYLIDÆ.

There is one specimen of what is evidently a member of this family but it is too badly preserved to place with any degree of certainty. The neuration is different from that of any genus with which I am familiar. In venation it seems to approach *Eupsenella* Westwood, but there is only a single submarginal cell. The antennal joints are short, but little longer than wide. The form of the marginal cell is very ant-like, but the antennæ are evidently not geniculate.

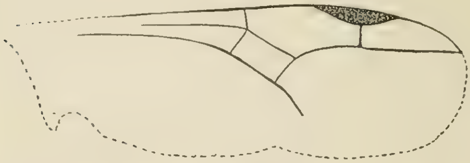


Fig. 7. Problematic Bethylid. Fore wing. Dotted lines are restored.

The single specimen, (see fig. 7) which must represent a new genus, is from the south end of Fossil Stump Hill, Florissant, Colorado.

Public Museum, Milwaukee, Wis., October 3, 1906.

56.57,93(118:78.8)

Article XXX.—FOSSIL SAW-FLIES FROM FLORISSANT, COLORADO.

By T. D. A. Cockerell.

Dineura saxorum sp. nov.

Length about 7 mm.; width of abdomen 2 mm.; anterior wing about 6 ½ mm.; wings hyaline, nervures fuscous; the head and thorax were apparently black; abdomen brown, with light bands on the first five segments, those on the second, third, and fourth more or less interrupted in the middle; the apical segments appear to have lateral spots.

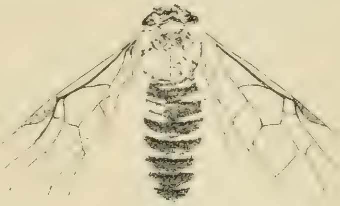


Fig. 1. *Dineura saxorum* sp. nov.

The venation agrees well with *Dineura* (*cf.* Macgillivray, Pr. U. S. Nat. Mus., XXIX, pl. xxxiii, fig. 63), but unfortunately, although the wings are for the most part well preserved, the basal region is obscure, so that it is impossible to be absolutely sure about the form of the lanceolate cell. After very close scrutiny, however, I believe it is certainly petiolate, as in *Dineura*, not contracted in the middle and double as in *Hemichroa*. The venation agrees with Macgillivray's figure of *Dineura geeri*, differing only in slight details, as follows:

Anterior wing. — (1) Transverse costal nervure (Sc_1) a considerable distance basad of the insertion of the basal nervure, about as in *Pteronus;* (2) transversomedial nervure attached decidedly nearer base than apex of first discoidal cell, a character approached by *Pseudodineura;* (3) first discoidal cell longer, its base being more produced; (4) upper edge of second discoidal cell longer, as must follow from the shifting of the transversomedial nervure.

Hind wing. — (5) Nervure M_2 inserted a short distance basad of origin of R_4. (This character exists, much exaggerated, in *Hemichroa.*)

The following measurements are in μ:

Breadth of marginal cell	600.
Length of first submarginal cell	360.
" " second " " on marginal	930.
" " third " " " "	750.
Insertion of second recurrent nervure from end of second submarginal cell	135.
Insertion of basal nervure from base of first submarginal	600.
Transverse costal nervure from insertion of basal nervure	300.

Insertion of first recurrent nervure from lower apical corner of first submarginal cell	270.
Insertion of first recurrent nervure from insertion of second recurrent nervure	930.
Origin of basal nervure from (basad of) transversomedial	600.
Lower end of transversomarginal nervure from insertion of second transversocubital	150.
Insertion of transversomarginal from apex of stigma (along margin of latter)	165.

Hab. — Tertiary shales of Florissant, Colorado, at Station 13 (some ¾ mile S. W. of Florissant, on hill sloping south); collected July, 1906, by Dr. W. M. Wheeler. Type in Amer. Mus. Nat. Hist.

Eriocampa wheeleri sp. nov.

Head black; thorax and abdomen brown; apparently the extreme base of the abdomen and posterior end of thorax black; wings clear, nervures brown; breadth of thorax about 2 mm.; length of anterior wing about 6⅓ mm.; lanceolate cell well preserved, quite normal; apex of costal nervure thickened; venation of hind wings, so far as preserved, apparently normal.

The anterior wings agree well in most respects with *Eriocampa ovata*, as figured by Macgillivray. The differences are as follows: (1) Basal nervure inserted at *basal corner of first submarginal cell;* (2) basal side of first discoidal cell (*i.e.*, basal nervure) conspicuously longer than the oblique apical side, but the difference is not nearly so great as in *Eriocampoides;* (3) transverse marginal nervure much less oblique; (4) externomedial nervure straight except quite at its base, where it bends abruptly to join the subcostal.

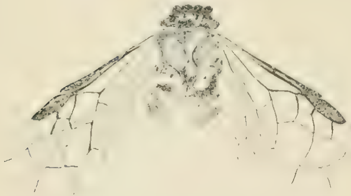


Fig. 2. *Eriocampa wheeleri* sp. nov.

The following measurements are in μ:

Length of first submarginal cell	450.
“ “ second “ “ on marginal	450.
“ “ third “ “ “ “	750.
Insertion of second transverse cubital to lower end of transverse marginal	450.
Length of basal nervure	750.
Basal nervure basad of transversomedial	300.
Upper insertion of transversomedial to origin of first recurrent nervure	555.
Insertion of first recurrent nervure from base of second submarginal cell	195.
Breadth of oblique apex of first discoidal cell	495.

Hab. — Tertiary shales of Florissant, Colorado, at Station 14 (some $\frac{3}{4}$ mile S. W. of Florissant, on hill facing north). Collected July, 1906, by Dr. W. M. Wheeler. Type in Amer. Mus. Nat. Hist.

Hemichroa eophila sp. nov.

Length about 10 mm.; of anterior wing about 9 mm.; breadth of thorax about $2\frac{1}{3}$ mm.; of abdomen $2\frac{3}{4}$ mm. Head and thorax black; abdomen a warm sepia brown, blackish on first two segments, and with dusky entire bands on the three following; wings hyaline, nervures brown.

This is a perfectly typical *Hemichroa*, excellently preserved. It differs as follows from Macgillivray's figure of *H. americana* (Pr. U. S. Nat. Mus., XXIX, pl. xxxiii, fig. 62):

(1) Transverse costal nervure a little more basad of basal nervure. (2) Third submarginal cell somewhat longer in proportion to its height. (3) Transversomedial inserted well before middle of first discoidal cell.

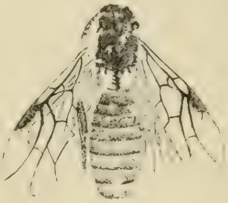


Fig. 3. *Hemichroa eophila* sp. nov.

The transverse marginal nervure arises from stigma about 180 μ from its end and is curved, passing obliquely down to reach the lower border of marginal cell about 180 μ beyond insertion of second transversocubital. The lanceolate cell is well preserved, and formed as in typical *Hemichroa.* The venation of the hind wings is also typical and serves to distinguish the insect from *Dineura.* Except for the lanceolate cell, there is a good deal of resemblance to *Pseudodineura;* the wings show the following differences from *Pseudodineura hepaticæ*, as figured by Macgillivray (Pr. U. S. Nat. Mus., XXIX, pl. xxxiv, fig. 65):

(1) Stigma and marginal cell conspicuously longer; (2) transverse costal nervure more basad of basal nervure; (3) first discoidal cell narrower above; (4) third submarginal cell longer.

The following measurements are in μ:

Length of first submarginal cell	405.
" " second " " on marginal	1200.
" " third " " " "	750.
Upper margin (on subcostal nervure) of first discoidal cell, about	450.
Transverse costal nervure basad of insertion of basal nervure .	180.
Origin of basal nervure from transversomedial . . .	600.
Breadth of marginal cell	900.
Length " " "	3300.
Insertion of first recurrent nervure from insertion of second.	900.

Hab.—Florissant, Colorado, in tertiary shales at Station 14. Collected July, 1906, by Mr. S. A. Rohwer. Type in Am. Mus. Nat. Hist.

INDEX TO VOLUME XXII.

[New names of genera, species, and subspecies are printed in **heavy-faced** type; also the main reference in a series of references.]

Acanthopelma maculata, 185.
Accœnites defunctus, 493.
    luridus, 494.
Admetus whitei, 188.
Adocus, 30, 159.
Aello megalophylla senicula, 261.
Agapostemon, sp., 419, 420.
    coloradensis, 427.
    texanus, 419, 427.
Agomphus, 30, 159.
Aimophila ruficeps scottii, 173.
Alcidamea, 420, 445.
    simplex, 445.
Alcimosphenus licinus, 185.
Allen, J. A., mammals from the States of Sinaloa and Jalisco, Mexico, collected by J. H. Batty during 1904 and 1905, 191–262; mammals from the Island of Hainan, China, 463–490.
Allosaurus, 283–295.
Amberleya capatanaca, 133.
Amblytropidia (?), 115.
Ammonites cordiformis, 133, 401.
    ishmæ, 131.
    ishmæ var. arcticus, 131, 132.
    schefkini, 131.
    (Amaltheus) cordiformis, 401.
    (Cadoceras) arcticus, 133, 134.
    (Cadoceras) ishmæ var. arcticus, 133, 134.
    (Macrocephalites) ishmæ var. arcticus, 134.
    (Macrocephalites) macrocephalus, 131, 134.
    (Œgoceras) **subtumidum,** 400.
Amphiacusta annulipes, 118.
    bahamenis, 118.
Amphicyon, 381.
Amphispiza bilineata grisea, 173.
Anahita, sp., 188.
Anchitherium, 385, 388.
    ultimum, 385.
Andrena, 419.
    atala, 430.
    birtwelli, 430.
    claytoniæ, 431.
    colletina, 454.
    cratægi, 431.
    cyanophila, 431, 432.
    danningi, 434.
    fragiliformis, 430, **435.**
    hirticincta, 434.
Andrena, **lappulæ,** 437.
    lewisii, 430, **435.**
    medionitens, 430.
    mentzeliæ, 434, 455.
    micranthophila, 430, **432.**
    multiplicata, 432.
    prunorum gillettei, 430.
    ribesina, 430, **433,** 434.
    runcinatæ, 430, **434.**
    semipunctata, 432.
    sieverti, 430, **436.**
    sp., 437.
    striatifrons, 432.
    synthyridis, 430, **436.**
    topazana, 430, **434.**
    vicina **argentiniæ,** 430, 432.
Andronicus, 445.
Anergates, 35.
    atratulus, 95.
Anisolabis annulipes, 109.
    azteca, 109.
Anomosaurus, 25.
Anosteira, 158–160.
    anglica, 159.
    ornata, 157.
Antedon, 123, 125.
    discoidea, 125, 126.
Anthidium, 420.
    emarginatum, 444.
    maculosum, 445.
Anthophora bomboides, 419.
    neomexicana, 419, 443.
    simillima, 443.
    (Micranthophora) flexipes, 443.
Anthracotherium, 365, 381.
Anthus pensilvanicus, 180.
Antrostomus vociferus macromystax, 167.
Ants, habits of the tent-building, 11–18; founding of colonies of, by queen, 33–105; of Japan, 301–328; of the Grand Cañon, 329–345; of the Bermudas, 347–352 maladjustments in the relations of, to plants, 403–418.
Anyphæna velox, 186.
Aonyx leptonyx, 480.
Aphænogaster aciculata, 315.
    famelica, 303.
    texana, 332.
Aphelocoma grisea, 169.
    sieberii wollweberi, 170.
Aphelops, 381.

Aphlebia, 113.
  inusitata, 113.
Apis mellifera ligustica, 454.
Arachnida, Bahaman, 185–189.
Arca, 133.
Archæohippus, 385–388.
  ultimus, 385, 387.
Arctocynidæ, 357.
Arsinoitherium, 363.
Ashmeadiella, 420, 445, 446.
Asio wilsonianus, 164.
Aspideretes, 156.
  gangeticus, 156.
Astarte **dacotensis,** 394.
  inornata, 396.
Astragalinus psaltria hesperophilus, 175.
Astroceras pergamena, 127.
Asturina plagiata, 163.
Atherurus **hainanus,** 464, **470–472.**
Atta, sp., 41, 43–45.
  sexdens, 42, 46, 91, 95.
Attii, 35.
Auriparus flaviceps flaviceps, 182.
Azteca, 13.

BAËNA, 155, 156.
  arenosa, 155.
  pulchra, 156, 157.
  undata, 155, 156.
Bæolophus wollweberi annexus, 182.
Bahamas, Orthoptera of, 107–118; Arachnida from, 185–189.
Balantiopteryx plicata, 235.
Banks, Nathan, Arachnida from the Bahamas, 185–189.
Baptemys, 157.
  wyomingensis, 30.
Barytherium, 363.
Basilemys, 30.
Bassariscus astutus astutus, 253.
Batagur, 28.
Bees of Florissant, Colorado, 419–455.
Belemnites beyrichi, 134.
  densus, 133, 134, 399.
  obtusus, 399.
  panderi, 133, 134.
  subextensus, 134.
Bethylidæ, sp., 497.
Black Hills of Dakota, Jurassic fossils of the, 389–402.
Blatta adspersicollis, 110.
  dilatata, 110.
  pavida, 110.
  vitrea, 110.
  zapoteca, 110.
  (Phyllodromia) delicatula, 109.
Blattella adspersicollis, 110.
  azteca, 110.
  punctulata, 110.
Bombus, 420.
  appositus, 453.
  dorsalis, 453.
  dubius, 453.
  edwardsii, 453.
  huntii, 419, 453.
  iridis phaceliæ, 454.
  juxtus, 453.
  morrisoni, 453.
  nevadensis, 453.
  rufocinctus, 454.
  rufosuffusus, 453.
  ternarius, 419.
Boremys, 157.
Bothriomyrmex meridionalis, 104.
Brachymyrmex heeri, 11, 17, 350.
  heeri var. obscurior, 350.
Brachyponera solitaria, 302.
Bridger beds of Wyoming, volcanic ash in, 273–280.
Brown, Barnum, new notes on the osteology of *Triceratops*, 297–300.
Brues, Charles T., fossil parasitic and phytophagous Hymenoptera from Florissant, Colorado, 491–501.
Bulimus teres, 459.
Buteo borealis calurus, 164.
  swainsoni, 163.
Butorides virescens anthonyi, 162.

CADOCERAS arcticus, 132.
Calamospiza melanocorys, 172.
Callagur, 28.
Calliopsis, 420.
  coloradensis, 440.
  rhodophilus, 440.
Callipepla squamata squamata, 162.
Callocitta colliei, 170.
Calothorax lucifer, 167.
Camponotus, 13, 39.
  brunni, 303.
  ferrugineus, 39.
  herculeanus, 301, 302.
  herculeanus aterrimus, 325.
  herculeanus japonicus, 324.
  herculeanus ligniperdus, 325.
  herculeanus ligniperdus var. obscuripes, 325.
  herculeanus pennsylvanicus, 324.
  herculeanus punctatissimus, 325.
  herculeanus var. sachalinensis, 325.
  herculeanus vagus, 325.
  landolti, 327.
  maculatus maccooki, 332, 345.
  maculatus vicinus var. nitidiventris, 332, 345.
  marginatus, 302.
  marginatus brunni, 327.

Camponotus marginatus quadrinotatus, 326.
    marginatus vitiosus, 303, 325.
    novæboracensis, 39.
    obscuripes, 303.
    pennsylvanicus, 39, 104.
    pennsylvanicus var. japonicus, 301.
    quadrimaculatus, 327.
    ruficeps, 327.
    truncatus, 327.
    (Colobopsis) rothneyi, 302, 327.
    (Colobopsis) rothneyi krafti, 327
Camptonectes, 133.
Canis impavidus, 224.
    vigilis, 223, 253.
Cardiocondyla emeryi, 349.
Carpodacus mexicanus rhodocolpus, 175.
Case, E. C., on the skull of *Edaphosaurus pogonias* Cope, 19–26.
Catherpes mexicanus, 181.
    mexicanus albifrons, 181.
    mexicanus conspersus, 181.
    mexicanus polioptilus, 181.
Centrurus vittatus, 188.
Centurus aurifrons, 165.
Ceratina, 420.
    neomexicana, 444.
Ceratinoptera diaphana, 110.
Cerchneis sparveria phalœna, 163.
Certhia familiaris albescens, 182.
Cervulus muntjac, 468.
    reevesi, 468.
    vaginalis, 468, 490.
Cervus eldi, 468.
    equinus, 467.
    hippelaphus, 467.
    unicolor equinus, 467.
Ceryle alcyon, 164.
    americana septentrionalis, 164.
Chelostoma, 445.
Chelydra crassa, 30.
Chelynia, 420.
    elegans, 445.
    monticola, 445.
Chilonycteris mexicana, 261.
Chironomus, sp., 416.
Chisternon, 155–157.
    hebraicum, 155, 156.
    undatum, 156.
Chœronycteris mexicana, 261.
Chondestes grammacus strigatus, 175.
Chonocephalus dorsalis, 267.
Chordeiles acutipennis texensis, 166.
Chortophaga cubensis, 108, 115.
Cidaris **bellefourchensis,** 391.
Citellus (Otospermophilus) variegatus couchi, 245.
    (Otospermophilus) variegatus rupestris, 245.
Citellus (Otospermophilus) variegatus variegatus, 244.
    (Xerospermophilus) mexicana mexicana, 245.
Clausilia occidentalis, 459.
    teres, 459.
Clisodon terminalis, 443.
Cockerell, T. D. A., the bees of Florissant, Colorado, 419–455; a fossil *Cicada* from Florissant, Colorado, 457, 458; the fossil Mollusca of Florissant, Colorado, 459–464; fossil saw-flies from Florissant, Colorado, 499–501.
Cœligena clemenciæ, 167.
Cœlioxys, 420.
Colaptes cafer collaris, 165.
Colletes, 420, 455.
    ciliata, 425.
    florissantia, 425.
    gaudialis, 425.
    kincaidii, 424.
    nigrifrons, 424.
    oromontis, 424, 425.
    parvulus, 455.
    phaceliæ, 424.
    polemonii, 425.
    salicicola geranii, 424.
    sieverti, 424.
    skinneri, 425.
Columba fasciata fasciata, 163.
Columna haydeniana, 459.
    teres, 459.
Commoptera, 267.
Comptonectes bellistriata, 397.
Condylarthra, 358.
Conepatus mesoleucus mearnsi, 259.
    sonoriensis, 225, 258.
Conocephalus nieti, 116.
Corvus corax sinuatus, 170.
Coryphodon, 361.
Coturniculus savannarum bimaculatus, 175.
Cremastogaster, 13, 39, 415, 416.
    artifex, 14.
    ashmeadi, 2.
    ebeninus, 13.
    inconspicua, 14.
    kirbyi, 13.
    laboriosa, 303, 312.
    laboriosa var. matsumurai, 312, 328.
    lineolata, 1–18, 332, 336, 413.
    lineolata pilosa, 6, 7, 413, 418.
    margaritæ, 14.
    minuta, 2.
    montezumia, 14.
    osakensis, 303.
    ranavalonæ, 14.
    rogenhoferi, 13.
    sordidula, 302.

Cremastogaster sordidula var. osakensis, 312.
  stadelmanni var. intermedia, 14.
  stolli, 14, 17.
  sulcata var. ramulinida, 14.
  tricolor, 14.
Crocidura murina, 481.
  (Pachyur) murina, 481.
Ctenus, sp., 188.
Culex, 416.
Cyanocitta stelleri diademata, 169.
Cycloptilum americanum, 118.
Cynodictis, 381.
Cyrtonyx montezumæ mearnsi, 162.
Cyrtoxipha, sp., 118.

DASYPTERUS xanthinus, 235.
Dendroica æstiva dugesi, 180.
  æstiva sonorana, 180.
  auduboni auduboni, 180.
  auduboni nigrifrons, 180.
Dermanura phæotis, 237.
  tolteca, 261.
Dermatemys, 158, 159.
Desmodus rotundus, 262.
Dianthidium, 420.
  cressonii, 445.
Didelphis, 194.
  mesamericana mesamericana, 195.
  mesamericana tabasensis, 195.
Didelphys, 381.
Didolodus, 358.
Dimetrodon, 22, 23.
Dineura **saxorum**, 499.
Diplocentrus lesueuri, 188.
Dipoëna crassiventris, 187.
Dipoides, 381.
Dolichoderus, 13.
  mariæ, 415.
  plagiatus pustulatus var. inornatus, 415.
Dorymyrmex pyramicus, 332, 333, 342, 343.
  pyramicus var. **bicolor**, 335, **342**.
Dryobates arizonæ arizonæ, 166.
  scalaris bairdi, 166.
  villosus hyloscopus, 166.
Dynamosaurus, 281, 296.
  imperiosus, 281, 282.

Echmatemys, 27.
  septaria, 28.
Ecitomyia, 267.
  wheeleri, 267, 269.
Eciton schmitti, 95.
Ectoconus, 358.
Ectomomyrmex japonica, 302.
Edaphosaurus, 19–25
  pogonias, 19–26.
Edmondia, sp., 133.
Elotherium, 365, 381.
Emphoropsis, 420.
  mucida, 419, 443.
Empidonax canescens, 167.
  fulvifrons pygmæus, 168.
  pulverius, 168.
  trailli trailli, 167.
  wrightii, 167.
Emys, 27.
  cibollensis, 29.
  lativertebralis, 29.
  orbicularis, 27.
  septaria, 27.
Epeira labyrinthea, 187.
  wittfeldæ, 187.
Epeolus beulahensis, 442.
Epilampra blattoides, 110.
Equus caballus, 149.
Erginus **castaneus**, 189.
Eriocampa **wheeleri**, 500.
Eugenes fulgens, 167.
Eumicrotis curta, 133.
Euphagus cyanocephalus, 170.
Euponera (Brachyponera) solitaria, 302, 306, 328.
Euprotogonia, 358.
Eurycotis, 110.
  bahamensis, 110.
Eutamais, 475.
Exyra ridingsii, 415.
  rolandiana, 415.
  semicrocea, 415.

FELIS brasiliensis, 220.
  cacomitli, 222.
  centralis, 216.
  chinensis, 477.
  glaucula, 253.
  hernandezii, 214, 216, 218.
  hernandezii goldmani, 216.
  limitis, 220.
  macrocelis, 464, 478.
  onca, 216–218.
  onca goldmani, 215.
  oregonensis aztecus, 221, 253.
  pardalis, 220, 221.
  pardalis albescens, 219–221.
  ricketti, 478.
  scripta, 478.
Filistata hibernalis, 185.
Formica, 3, 39, 97.
  ciliata, 47, 92.
  cinerea var. neocinerea, 47, 412.
  consocians, 33, 41.
  dakotensis, 47, 92.
  dakotensis wasmanni, 47, 92.
  difficilis, 47, 58, 63, 64.
  difficilis var. consocians, 47, 50–58, 60–67, 70–73, 86, 89–92, 95–97, 99–102, 104, 105.
  dryas, 47, 64.

Formica dryas var. gymnomma, 47.
  exsectoides, 46, 51, 71–73, 92, 93, 101, 105, 403, 404, 406, 409, 410, 418.
  exsectoides var. opaciventris, 47, 71, 405, 410.
  exserta, 47–49, 89–90, 94, 98, 102, 409, 410.
  fusca, 46, 47, 64, 91, 92, 94, 97, 98, 101, 302, 344.
  fusca var. argentata, 46, 68, 332, 344.
  fusca var. gnava, 46, 93, 332, 334, 344.
  fusca var. montana, 47.
  fusca var. neoclara, 47, 344.
  fusca var. neorufibarbis, 47, 332, 344.
  fusca var. nipponensis, 301, 323.
  fusca var. subænescens, 46, 104.
  fusca near var. subænescens, 415.
  fusca var. subpolita, 345.
  fusca var. subsericea, 46, 50, 51, 64, 65, 67–86, 92, 96–98, 100, 302, 323, 344, 405, 406.
  fusciceps, 303.
  impexa, 47, 92, 104.
  lasiodes, 47.
  lasiodes var. picea, 47.
  microgyna, 47, 64, 92, 104.
  microgyna rasilis, 47.
  moki, 332, **343**, 344.
  montigena, 47, 64, 92.
  munda, 47.
  nepticula, 33, 47, 53, 64–67, 92.
  nevadensis, 47, 64, 92.
  nigra, 352.
  nipponensis, 301, 303.
  oreas, 47, 92.
  pallide-fulva, 47, 48, 64, 91, 92, 94, 344.
  pallide-fulva subsp. schaufussi, 47, 48, 50, 51, 53, 64, 86–89, 98.
  pallide-fulva subsp schaufussi, var. incerta, 47, 50, 51, 53–62, 64, 65, 70, 89, 90, 105.
  pallide-fulva subsp. schaufussi var. meridionalis, 47.
  pallide-fulva subsp. schaufussi var. nitidiventris, 47, 52, 62.
  pallide-fulva subsp. schaufussi var. succinea, 47.
  pergandei, 47, 48, 85.
  pilicornis, 47.
  pratensis, 405, 409.
  rufa, 11, 33, 46–50, 63, 64, 67–69, 72, 89, 90, 92–94, 98, 302, 344, 404, 405, 409, 412.
Formica rufa integra, 11, 12, 18, 47, 53, 67–72, 80, 92, 105.
  rufa integra var. hæmorrhoidalis, 47, 68.
  rufa obscuripes, 47, 68.
  rufa obscuriventris, 47, 68.
  rufa obscuriventris integroides, 47.
  rufa obscuriventris melanotica, 47, 68.
  rufa obscuriventris rubiginosa, 47, 68.
  rufa pratensis, 47, 93, 323.
  rufa pressilabris, 47.
  rufa truncicola, 47, 92, 93, 323.
  rufa truncicola yessensis, 303, 323.
  rufibarbis, 47, 97, 413.
  rufibarbis var. occidentalis, 47.
  sanguinea, 33, 35, 47–49, 53, 85, 89, 98, 100, 101, 302, 322.
  sanguinea subsp. aserva, 74, 85, 86, 89, 96, 322.
  sanguinea subsp. obtusopilosa, 47.
  sanguinea subsp. puberula, 47.
  sanguinea subsp. rubicunda, 47, 74–87, 96–98, 100–102.
  sanguinea subsp. rubicunda var. subintegra, 47, 73, 74, 84–86, 89, 96.
  sanguinea subsp. subnuda, 47.
  sanguinea var. fusciceps, 322.
  subpolita, 47, 332, 344.
  subpolita var. neogagates, 47, 51, 64–67.
  subpolita var. perpilosa, 47.
  ulkei, 47, 410.
Fulica americana, 162.
Funambulus pyrrhomerus, 473.
  riudonensis, 464, **472.**

GASTERACANTHA cancriformis, 187.
Geococcyx californianus, 164.
Geothlypis trichas arizela, 179.
  trichas melanops, 179.
  trichas occidentalis, 179.
Gidley, J. W., a new genus of horse from the Mascall beds, with notes on a small collection of equine teeth in the University of California, 385–388.
Gidley, J. W., and W. D. Matthew, on new or little known mammals from the Miocene of South Dakota, 135–153. See also Matthew, W. D.
Gingko polaris, 132.
  reiniformis, 132.
  sibirica, 132.
Glossophaga mutica, 236, 261.

Goniobasis, 274.
Gryllodes poeyi, 117.
Gryllus assimilis, 117.
  bryanti, 117.
Guiraca cærulea lazula, 172.

Habropoda, sp., 419.
Halerpestes cymbalaria, 437.
Halictoides, 420.
  harveyi, 439.
Halictus aberrans, 427.
  aquilæ, 420.
  armaticeps, 427
  clematisellus, 429.
  cooleyi, 427.
  galpinsiæ, 427.
  lerouxii, 427.
  mesillensis, 429.
  pictus, 429.
  pruinosiformis, 429.
  ruidosensis, 429.
  sisymbrii, 427.
  sp., 454.
  synthyridis, 428.
  trizonatus, 427.
  veganus, 429.
  (Chloralictus) **scrophulariæ,** 428.
  (Chloralictus) sp., 429.
  (Evylæus) **synthyridis,** 427.
Halobia, 133.
Hardella, 28.
Hatteria, 283, 287, 288.
Hay, Oliver P., description of two new genera (*Echmatemys* and *Xenochelys*) and two new species (*Xenochelys formosa* and *Terrapene putnami*) of fossil turtles, 27–31; on two interesting genera of Eocene turtles, *Chisternon* Leidy and *Anosteira* Leidy, 155–160.
Helaletes, 361.
Heleodytes brunneicapillus obscurus, 182.
Helicoceras, 133.
Helictis moschata, 480.
Helix nebrascensis, 459.
  occidentalis, 459.
Helminthophila celata lutescens, 180.
  celata orestera, 180.
Hemiblabera brunneri, 112.
  sp., 112.
Hemichroa **eophila,** 501.
Hemiphrynus viridiceps, 189.
Heriades, 420, 445.
Herpestes griseus, 479.
Heteroceras, 133.
  stevensoni, 133.
Heteromys, 239, 251.
  canus, 251.
  jaliscensis, 251.
Heteromys pictus, 211, 212, 250, 251.
  pictus **escuinapæ, 211,** 249, 250.
  pictus pictus, 249.
  pictus plantinarensis, 211, 249–251.
Heteropoda venatoria, 185.
Hipparion speciosum, 152.
Hipposideros fulvus, 484.
  larvatus, 484.
  leptophyllus, 484.
  murinus, 484.
  poutensis, 464, 483.
Hirundo erythrogaster, 176.
Hololampra, 113.
Holospira leidyi, 459
Hoplitis, 445.
Hoplochelys, 30.
Horizopus pertinax pallidiventris, 168.
  richardsonii richardsonii, 168.
Hovey, E. O., see Whitfield, R. P.
Hyænodon, 361.
Hyalina (?) occidentalis, 459.
Hylobates hainanus, 463, 489, 490.
  pileatus, 489.
Hypohippus, 136, 385, 386, 388.
  affinis, 135.
  equinus, 135.
Hyrachyus, 361.
Hyrax, 263.
  capensis, 263, 265.
  syriacus, 265.
Hystrix hodgsoni,, 471, 472.
  sp. incog., 464, 472.
  subcristatus, 471, 472.

Icteria virens longicauda, 179.
Icterus bullockii bullockii, 171.
  spurius, 172.
Iridomyrmex analis, 332, 333, 342.
  glaber, 318.
  humilis, 348.
  itoi, 302, 303, 318.
  itoi **abbotti,** 302, 303, **318,** 328.
Ischnocolus hirsutus, 186.
Ischnomyrmex famelicus, 315.
Ischnoptera blattoides, 110.
Ischnothele guyanensis, 186.
Isectolophus sp., 275, 361.
Isodontia philadelphica, 415.
Isometrus maculatus, 188.

Junco caniceps, 174.
  phæonotus palliatus, 174.
Jurassic fossils from Franz Josef Land, 131–134; of the Black Hills of Dakota, 389–402.

Kachuga, 28.

Labidura bidens, 109.

Lachnus, sp., 3.
Lanius ludovicianus, 178.
  ludovicianus excubitorides, 178.
Lanivireo solitarius cassinii, 179.
  solitarius plumbeus, 179.
Lasiurus borealis mexicanus, 260.
  cinereus, 260.
Lasius alienus, 10.
  americanus, 332.
  brevicornis, 41.
  brunneus, 10, 11.
  emarginatus, 10, 11.
  flavus, 302.
  flavus myops, 322.
  fulignosus, 15, 302, 322.
  niger, 9, 10, 103, 302, 321, 342, 352.
  niger var. alienus, 322.
  niger var. americanus, 11, 105, 343.
  niger brunneus, 322.
  umbratus, 302, 322.
Lathrodectus mactans, 187.
Leda nuda, 133.
Leptonycteris nivalis, 236.
Leptothorax congruus, 303, 316.
  congruus var. spinosior, 317.
  emersoni, 90, 95, 412.
  neomexicanus, 332, 341.
  nitens, 332, 341.
  spinosior, 303.
  tuberum, 317.
Lepus alleni, 213, 214.
  alleni palitans, 213.
  callotis, 252.
  floridanus, 252.
  floridanus subcinctus, 252.
  hainanus, 463, 468–470, 490.
  insolitus, 212.
Leucauge argyra, 187.
Leucophæa maderæ, 112.
Liometopum, 13.
  apiculatum luctuosum, 332, 341.
  microcephalum, 91.
Liphoplus krugii, 117.
Lithocicada, 457.
  perita, 457.
Lithodomus, 398.
Lithoryssus, 491.
  parvus, 492.
Lophiodon, 361.
Lophiotherium, 361.
Lophortyx douglasi douglasi, 162.
Lutra, 381.
  annectens, 235.
  chinensis, 479.
  cinerea, 464.
  lutra, 480.
  sp., 479.
Lymnæa **scudderi**, 460.
  sieverti, 461.
Lynx, 194.
  ruffus baileyi, 223.
  ruffus escuinapæ, 222.
Lyroscelus bonhotei, 185.
Lysinoe nacimientensis, 459.

Macacus erythræus, 488.
  rhesus, 488.
McClendon, J. F., the Myzostomes of the 'Albatross' Expedition to Japan, 119–130.
Macrodon schonrovski, 133.
Malacomorpha, 113.
  androsensis, 114.
Mammals, new or little known, from the Miocene of South Dakota, 135–153; from Sinaloa and Jalisco, Mexico, 191–262; from the Island of Hainan, 463–490.
Manis aurita, 466.
  dalmanni, 465, 467.
  javanica, 466.
  pentadactyla, 466.
  pusilla, 464, **465–467.**
Marmosa sinaloæ, 194, 239.
Matthew, W. D., hypothetical outlines of the continents in Tertiary times, 353–383.
Matthew, W. D., and J. W. Gidley, new or little known mammals from the Miocene of South Dakota, 135–153. See also Gidley, J. W.
Megachile, 420, 452.
  giliæ, 452.
  latimanus, 452, 453.
  manifesta, 454.
  montivaga, 452, 453.
  pugnata, 452, 453.
  relativa, 454.
  vidua, 453.
  wootoni, 452.
  wootoni **rohweri,** 453.
Megacilissa, 419.
Megalohyrax, 263.
  eocænus, 265.
Megaquiscalus major macrourus, 170.
Megascops asio aikeni, 164.
  trichopsis, 164.
Melanerpes formicivorus formicivorus, 165.
Melissodes confusa, 443.
  hymenoxidis, 443.
  menuacha, 443.
  pallidicincta, 443.
  perplexa, 443.
Melopelia leucoptera, 163.
Melospiza lincolnii lincolnii, 173.
Mephitis, 193, 259.
  macroura macroura, 257.
Merula migratoria propinqua, 183.

Merychippus, 388.
Mesohippus, 385–388.
  bardi, 385.
Mesostenus **modestus,** 492.
Messor aciculatus, 303.
Metacheiromys, 361.
Metacrinus, 120.
  rotundus, 119, 121–124.
Microgaster **primordialis,** 496.
Microtus, 239.
  phæus, 249.
Miller, Waldron De Witt, list of birds collected in northwestern Mexico, by J. H. Batty, during 1903, 161–183.
Mimus polyglottos leucopterus, 181.
Miniopterus pusillus, 485.
  schreibersi, 485.
Miohippus, 386.
Modiola **jurassica,** 393.
  (Volsella) formosa, 393.
Modiolarca **jurassica,** 393.
Mogoplistes barbouri, 118.
Molossus nigricans, 236, 260.
  obscurus, 236, 260.
  pretiosus, 236.
  sinaloæ, 236.
Molothrus ater obscurus, 172.
Monomorium atomus, 311.
  destructor, 311, 348.
  floricola, 302, 310.
  intrudens, 310.
  minutum, 349.
  minutum var. minimum, 332, 336.
  nipponense, 302, 303, **310.**
  pharaonis, 349.
  salomonis, 104.
  triviale, 302, 303, **311.**
Monumetha albifrons, 446.
Multituberculata, 357–359.
Murinus cyclotis, 487.
Mus, 193.
  alexandrinus, 208, 246.
  decumanus, 472.
  musculus, 208.
  norvegicus, 464, 472.
  rattus, 246.
  sp., 472.
Mustela, 381.
Myadestes townsendi, 183.
Myiarchus cinerascens cinerascens, 168.
  lawrencei olivascens, 168.
Myotis abramus, 464, 488.
  californicus mexicanus, 260.
  davidii, 488.
  nigricans, 260.
  thysanodes, 260.
  velifer, 260.
Myrmecina graminicola, 302.
  graminicola americana var. brevispinosa, 332, 335.
  graminicola **nipponica,** 302, 303, **307.**
Myrmecocystus melliger, 333, 335, 345.
Myrmica, 39, 412, 417.
  brevinodis, 95.
  fracticornis, 316.
  lævinodis, 11, 302.
  lobicornis, 302.
  rubra brevinodis, 412, 417.
  rubra lævinodis, 315.
  rubra lobicornis var. jessensis, 316.
  rubra scabrinodis, 11, 316, 332, 340.
  ruginodis, 38.
  schencki, 316.
Mytilus whitei, 394.
Myzostoma ambiguum, 123.
  antennatum, 123, 129, 130.
  chelonium, 126, 129.
  chelonoidium, 126, 129.
  cirriferum, 126, 127.
  clarki, 119, **121,** 129, 130.
  cryptopodium, 122.
  cysticolum, 120, 129.
  cysticolum var. **orientale,** 120.
  deani, 124, 129.
  glabrum, 127.
  japonicum, 127, 129, 130.
  metacrini, 119, **122,** 129.
  smithi, 125, 129.
  wheeleri, 124, 129.

Naosaurus, 24, 25.
Nasua, 193.
  narica molaris, 227–235, 255, 256.
  narica narica, 254, 255.
Nemobius alleni, 116.
  sp., 117.
Neohipparion, 142, 146, 147.
  affine, 148.
  dolichops, 148–152.
  gratum, 145–152.
  niobrarense, 151–153.
  occidentale, 145, 149.
  whitneyi, 138, 139, 148, 149.
Neotoma, 193, 239.
  sinaloæ, 249.
Nephila claviceps, 187.
Neritoma (Oncochilus) **occidentalis,** 399.
Nomada, 420.
  crawfordi, 437.
  cymbalariæ, 439.
  ornithica, 437.
  rohweri, 438.

Nomada ruidosensis, 438.
taraxacella, 437.
Nomia nortoni, 419.
Notharctus, 361.
Notoprotogonia, 358.
Nucula, sp., 133.
Numenius longirostris, 162.
Nycticejus luteus, 485.
Nyctinomus mexicanus, 236, 260.
plicatus, 482.
Nylanderia imparis, 332.

Odocoileus sinaloæ, 203, 206, 207, 220, 240–242.
virginianus, 205.
Odontomachus clarus, 39.
hæmatodes, 39.
hæmatodes insularis, 349.
hæmatodes insularis var. pallens, 113.
hæmatodes insularis var. ruginodis, 349.
sp., 349.
Omphalina (?) **laminarum,** 459.
Ophioaster, 391.
Ophiocreas, sp., 127.
Ophiocten (?) **bellefourchensis,** 391.
Orchippus, 361.
Oreopasites, 420, **442.**
scituli, 442.
Oreospiza chlorura, 172.
Orocharis gryllodes, 118.
Orphulella olivacea, 115.
pelinda, 115.
Ortalis wagleri, 163.
Orthocentrus **primus,** 495.
Orthoptera, Bahaman, 107–118.
Oryzomys, 239.
melanotis, 210.
mexicanus mexicanus, 210.
Osborn, Henry Fairfield, milk dentition of the hyracoid *Sagatherium* from the Upper Eocene of Egypt, 263–266; *Tyrannosaurus*, Upper Cretaceous Carnivorous Dinosaur (second communication), 281–296.
Osmia, 420.
abjecta, 447.
albolateralis, 447, **450.**
armaticeps 447.
bruneri, 446, 447.
chlorops, 448.
cyaneonitens, 446, **448.**
densa, 447, 448.
faceta, 448.
florissanticola, 447, **450.**
fulgida, 446, 447.
giliarum, 447, **451.**
hypochrysea, 447, **449.**
nigrifrons, 447, 448.
Osmia **panzer,** 446.
pentstemonis, 447, **451.**
proxima, 449.
subtrevoris, 447, **451.**
wheeleri, 449, 451.
wilmattæ, 447, 448.
Ostrea strigillecula, 397.
Otocoris alpestris aphrasta, 168, 169.
occidentalis, 168, 169.
Oxyechus vociferus, 162.

Pachyæna, 361.
Pachycondyla ochracea, 305.
(Ectomomyrmex) japonica, 304.
(Pseudoponera) **sauteri, 304,** 328.
Pachynolophus, 361.
Paguma larvata, 479.
Palæomeryx, 381.
Palæonictis, 361.
Palæosyops, 361.
Palæotherium, 361, 387.
Paludina, 274.
Panolia eldi, 490.
eldi platyceros, 464.
Pantoclis **deperdita,** 497.
Panurginus, 420.
cressoniellus, 439.
Parahippus, 385–387.
brevidens, 388.
cognatus, 388.
Paroxya atlantica, 116.
dissimilis, 116.
sp., 116.
Pecten lindstromi, 133.
Pentacrinus astericus, 389.
bavaricus, 390.
briarius, 390.
cingulatus, 390.
pentagonalis, 390.
scalaris, 390.
subangularis, 390.
Penthestes sclateri, 182.
Perdita **florissantella,** 440.
tortifoliæ, 440.
wilmattæ, 441.
zebrata, 440.
Periplaneta americana, 112.
australasiæ, 112.
Perognathus, 239.
flavus mexicanus, 249.
pernix pernix, 211.
Peromyscus, 192, 239.
hylocetes, 246.
labecula, 246.
melanotis melanotis, 246.
spicilegus simulus, 247.
spicilegus spicilegus, 208, 247.
(Baiomys) musculus, 247.
(Baiomys) musculus musculus, 209.

Petrochelidon lunifrons melanogaster, 177.
Phainopepla nitens, 178.
Pheidole ceres, 332, 337.
  desertorum, 337, 340.
  desertorum var. **comanche,** 339.
  desertorum var. **maricopa,** 333, 339.
  fervida, 302, 310.
  megacephala, 348–350.
  nodus, 302, 307, 328.
  pallidula, 91.
  pusilla, 349.
  rhombinoda, 309.
  vinelandica, 332, 336.
Pholadomya **obscura,** 398.
Pimpla **antiqua,** 494.
Pinna **jurassica,** 392.
Pipilo fuscus mesoleucus, 173.
  maculatus megalonyx, 172.
Pipistrellus abramus, 488.
  portensis, 464, **487.**
  ridleyi, 488.
  tenuis, 488.
Piranga hepatica, 175.
  rubra cooperi, 175.
Placodus, 20, 22, 25, 26.
Plagiolepis longipes, 348.
Plagiospiza superciliosa, 173.
Planorbis **florissantensis,** 460.
Platygeomys gymmerus, 239, 249.
Pleuromya (?) **concentrica,** 397.
Pliohyrax, 263, 265.
  græcus, 265.
  kruppii, 265.
Podozamites, 132.
Pogonomyrmex, 38.
  barbatus, 405.
  barbatus var. molefaciens, 37, 405.
  barbatus rugosus, 333, 341.
  californicus, 40, 105, 333, 335, 341.
  dentatus, 335.
  desertorum, 335.
  imberbiculus, 335.
  molefaciens, 91, 95.
  occidentalis, 332, 340, 405.
Polioptila plumbea, 182.
Polyergus, 35, 48, 89, 96–99.
  rufescens lucidus, 86–89, 96, 97.
Polymastodon, 357.
Polyrhachis, 13.
  craddocki, 328.
  lamellidens, 302, 327, 328.
Ponera **japonica,** 302, **306.**
  opaciceps, 332, 333, 335, 348.
  solitaria, 306.
Poœcetes gramineus confinis, 175.
Potamotherium, 381.
Prenolepis, 352.
  flavipes, 303, 320.
  guatemalensis, 333, 342.
  kincaidi, 347, **350,** 352.
  longicornis, 268.
  (Nylanderia) imparis, 332, 334, 342.
  (Nylanderia) imparis var. testacea, 342.
Pristomyrmex japonica, 302, 303, 317, 328.
  pungens, 318.
Prochelostoma, 445.
Procyon, 193.
  hernandezii, 226.
  hernandezii hernandezii, 254.
Progne subis hesperia, 177.
Prosopis, 420.
  antennata, 423.
  basalis, 423.
  divergens, 423.
  pygmæa, 423.
  tridentula, 423.
  tuertonis, 423.
  varifrons, 423.
Proteriades, 445.
Protohippus, 137, 138, 388.
  mirabilis, 140, 142–145.
  perditus, 136–138, 140, 141, 144, 146.
  placidus, 140–142, 146.
  simus, 139.
  supremus, 140, 143–145.
  (Pliohippus) pernix, 144.
  (Pliohippus) robustus, 144.
Protomognathus, 35.
Psaltriparus melanotis lloydi, 182.
Pseudomonotis jacksoni, 133.
Pseudoponera sauteri, 302.
Pseudotrionyx, 159, 160.
  delheidi, 159.
Psithyrus insularis, 453.
Psyllomyia, 267.
  testacea, 268.
Pterodon, 361, 363.
Pteronotus davyi fulvus, 236, 261.
Ptilodus, 357.
Puliciphora, 267–269.
  boriquenensis, 267–271.
  lucifera, 267, 268, 270.
  occidentalis, 268, 270.
Putorius frenatus frenatus, 259.
Pycnoscelus surinamensis, 112.
Pyrocephalus rubineus mexicanus, 167.
Pyrrhuloxia sinuata sinuata, 172.

QUENSTEDTIA **planulata,** 397.
Querquedula cyanoptera, 162.

RATUFA gigantea **hainana,** 464, **472.**

Regulus calendula cineraceus, 182.
Rehn, James A. G., the Orthoptera of the Bahamas, 107–118.
Reithrodontomys, 191, 239.
    colimæ, 249.
    tenuis, 210, 248.
Rhinolophus **hainanus,** 464, **482.**
    mitratus, 483.
Rhogas **tertiarius,** 496.
Rhynchophanes mccownii, 175.
Rhynchopsitta pachyrhyncha, 164.
Rhyssa **petiolata,** 494.
Ridgwayia pinicola, 183.
Robertsonella, 445.
Rusa unicolor equinus, 464, 467.

SAGHATHERIUM antiquum, 263–266.
    minus, 265.
Salpinctes obsoletus notius, 181.
Sarcophaga, 416.
Sauropoda, 295.
Sayornis nigricans nigricans, 168.
    saya, 168.
Scardafella inca, 163.
Schistocerca, 108, 109.
    alutacea, 109, 115.
    americana, 109, 116.
Sciurus, 381.
    castaneiventris, 473.
    erythræus **insularis,** 464, **473.**
    macclellandi, 475, 476.
    poliopus cervicalis, 243.
    poliopus colimensis, 243.
    poliopus nemoralis, 244.
    poliopus **tepicanus,** 243.
    sinaloensis, 208.
    vulgaris, 475.
Scotophilus castaneus, 486.
    castaneus **consobrinus,** 464.
    heathii, 485.
    kuhlii, 485.
    kuhlii **insularis,** 464, **485.**
    wroughtoni, 486.
Scytodes longipes, 186.
Selasphorus platycercus, 167.
Selenops aissus, 188.
Semnopithecus nemæus, 463, 464, 489, 490.
Septifera **sturgisensis,** 393.
Setophaga picta picta, 179.
Sialia mexicana bairdi, 183.
    sialis azurea, 183.
Sigmodon, 239.
    alleni, 209, 210.
    borucæ, 248.
    colimæ, 209, 210, 248.
    hispidus colimæ, 209, 247.
    hispidus major, 210.
    hispidus mascotensis, 209.
    mascotensis, 209, 248.
    toltecus, 248.
Sigmodon **vulcani, 247,** 248.
Sinclair, W. J., volcanic ash in the Bridger beds of Wyoming, 273–280.
Sitta carolinensis mexicana, 182.
Solenopsis fugax, 302, 307.
    geminata var. **aurea,** 333, **336,** 348, 349.
Sorex murinus, 481.
    myosurus, 481.
    oreopolus, 260.
Spectrellum mexicanum, 236, 260.
Sphærium **florissantense,** 461.
Sphecodes, 420.
    eustictus, 426.
    pecosensis, 426.
    sophiæ, 427.
    sulcatulus, 426.
    washingtoni, 427.
Sphenodon, 295.
Sphenophyllum, 132.
Sphyrapicus thyroideus, 166.
    varius nuchalis, 166.
Spilogale, 193.
    angustifrons angustifrons, 259.
Spinoliella, 420, 443.
    scitula, 426, 440, 443.
Spinus pinus pinus, 175.
Spizella pallida, 174.
    socialis arizonæ, 174.
Staurotypus, 158, 159.
    salvinii, 158.
Stelgidopteryx serripennis, 176.
Stelis, 420.
    montana, 445, 446.
Stenamma brevicorne, 314.
    owstoni, 303, **314.**
    (Aphænogaster) famelicum, 315.
    (Aphænogaster) fulvum, 92.
    (Aphænogaster) fulvum var. texanum, 341.
    (Aphænogaster) tennesseense, 92.
    (Ischnomyrmex) albisetum, 335.
    (Ischnomyrmex) cockerelli, 335.
    (Messor) aciculatum, 315.
    (Messor) aciculatum var. brunneicorne, 315, 328.
    (Messor) barbarum var. aciculatum, 315.
    (Messor) pergandei, 335.
Steneofiber, 381.
Stethopathus ocellatus, 267.
Stigmatomma pallipes, 95.
Stratægus julianus, 268.
Strongylognathus, 35.
Strumigenys godeffroyi var. lewisi, 302, 318, 328.
Sturnella neglecta, 171.
Sysphincta algirica, 304.
    europæa, 304.

Sysphincta mayri, 304.
  melina, 304.
  pergandei, 304.
  watasei, 302, **303,** 328.

TACHYCINETA thalassina lepida, 176.
Tafalisca lurida, 118.
Tamiops, 464, **475.**
  macclellandi **hainanus,** 464, **476.**
  macclellandi **rudoni,** 464, **477.**
Tancredia inornata, 396.
  transversa, 396.
Tapinoma erraticum, 104, 320.
  sessile, 320, 332, 342, 415.
Tatu novemcinctum mexicanum, 196, 240.
Tayassu angulatum, 198, 199.
  angulatum humerale, 240.
  angulatum sonoriense, 198.
  pecari, 201.
  tajacu, 201.
  torvum, 201.
Tayra barbara senex, 235.
Technomyrmex **gibbosus,** 302, 303, **319,** 328.
Teredo (?), 398.
Termitomyia, 268.
Termitoxenia, 268.
Terrapene carolina, 31.
  marmochii, 31.
  ornata, 31.
  putnami, 27, 30.
Tertiary times, hypothetical outlines of the continents in, 353–383.
Tetramorium cæspitum, 302, 317, 350.
  guineense, 350.
Theridium rufipes, 187.
  studiosum, 187.
Thomomys, 193, 239.
Thryomanes bewickii eremophilus, 181.
Titanotherium, 365, 381.
Titusella, 420, **445.**
  pronitens, 446.
Toxostoma curvirostre curvirostre, 180.
Trachemys euglypha, 30.
Trachymyrmex septentrionalis, 99.
Triceratops, 282, 296–300.
Triepeolus, 420.
Trigonia **poststriata,** 396.
  sturgisensis, 394.
Trionyx gangeticus, 156.
  hurum, 156.
  leithii, 156.
Trochilus alexandri, 167.
Trogon ambiguus, 164.
Tupaia **modesta,** 464, **481.**
Turbo (?), 133.

Tyrannosauridæ, 283.
Tyrannosaurus, 281–296.
  rex, 281, 282, 284.
Tyrannus vociferans, 168.

UINTATHERIUM, 361.
Uloborus americanus, 185.
  geniculatus, 185.
Unio, 274, 276, 279.
Urocyon cinereoargenteus scottii, 193, 224, 253.
Ursus, sp., 225, 464, 481.
  malayanus, 481.
  tibetanus, 481.
Urubitinga anthracina, 163.

VESPERTILIO fuscus, 260.
Vesperugo abramus, 488.
Vireo belli medius, 179.
  huttoni stephensi, 178.
Viverra zibetha, 479.
Viverricula malaccensis, 479.
Vollenhovia **emeryi,** 302, 303, **312,** 328.
  subtilis, 313.

WANDOLLECKIA, 267, 268.
  cooki, 267.
Wheeler, William Morton, the habits of the tent-building ant (*Cremastogaster lineolata* Say), 1–18; on the founding of colonies by queen ants, with special reference to the parasitic and slave-making species, 33–105; a new wingless fly (*Puliciphora borinquenensis*) from Porto Rico 267–271; the ants of Japan, 301-328; the ants of the Grand Cañon, 329–345; the ants of the Bermudas, 347–352; an ethological study of certain maladjustments in the relations of ants to plants, 403–418.
Wheeleria, 35.
  santschii, 104.
Whitfield, R. P., notes on some Jurassic fossils from Franz Josef Land, brought by a member of the Ziegler Exploring Expedition, 131–134.
Whitfield, R. P., and E. O. Hovey, remarks on and descriptions of Jurassic fossils of the Black Hills, 389–402.
Wilsonia pusilla chryseola, 179.
  pusilla pileolata, 179.
Wulfila **ventralis,** 186.
Wyeomyia, 416.
  smithii, 416.

XANIONOTUM, 267.
Xanthosmia, 449.
Xenochelys, 27, 29.
    formosa, 27, 29.
Xiphidion brevipenne, 116.
    fasciatum, 116.
    insulare, 116.

YOLDIA, sp., 133.

ZAMELODIA melanocephala, 172.
Zenaidura macroura macroura, 163.
Zonotrichia leucophrys leucophrys, 175.
Zygoramma, 30.

2515 /

BINDING SECT. SEP 12 1967

QH 1 A4 v.22
1906
Biological & Medical Serials

American Museum of natural history, New York
Bulletin

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

STORAGE